Lecture notes on

Emergency Medicine

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Chapter 1

EMERGENCY MEDICINE : INTRODUCTION

The practice of emergency medicine requires both a broad knowledge base and a large range of technical skills. The effective practice of emergency medicine requires a thorough comprehension of the assessment and management of conditions that threaten life and limb; the ability to provide immediate care is fundamental. Although there is a significant crossover between emergency medicine and other clinical specialties, emergency medicine has unique aspects, such as the approach to patient care and the decision making process.

1.1 HISTORY OF EMERGENCY MEDICINE

The history of emergency medicine as a distinct medical discipline encompasses the past 60 years. The genesis of emergency medicine involved several elements and stemmed from recognition of the unique nature of trauma care and emergency transport, increasing mobility of the population and improvements in emergency care and resuscitation. The American Board of Emergency Medicine became the twenty-third medical specialty, following its approval by the American Board of Specialties in September 1979. The first board examination in emergency medicine was offered in 1980.

In the early 1980's, the Australian Society of Emergency Medicine was formed by a group of doctors committed to the practice and development of emergency medicine, and in 1993 the discipline was accepted as a principal specialty.

These developments have led to the transformation in the practice of emergency medicine in most hospitals. However, away from the major centres, there are many non-specialist doctors playing an important role in the delivery of emergency care to seriously ill patients. These doctors often do so in relative isolation and without the benefit of the supervision and back up of specialists. Groups such as rural general practitioners and hospital based medical officers carry a significant emergency medicine role.

1.2 EDUCATION

In the United States, residents must complete a minimum training period of 36 months in an approved emergency medicine training residency programme before they can sit the Board examination. A typical residency curriculum includes the following assignments:

> emergency medicine, intensive care units, paediatrics, trauma surgery, toxicology, orthopaedics, neurology/neurosurgery, obstetrics and gynaecology, emergency medical services and electives.

The necessary technical skills and knowledge are acquired during residency training and in practice, and are published in texts that outline relevant procedures. Such skills include, but are not limited to, airway control, venous access, diagnostic procedures, pericardiocentesis and thoracocentesis.

South Africa is in the process of developing a full postgraduate specialist training programme, in addition to the Diploma in Emergency Medicine that is presently available. Many doctors have taken the opportunity to complete the excellent certification programmes available eg Acute Trauma Life Support, Acute Cardiac Life Support and

Acute Paediatric Life Support. These certification courses have done much to stimulate the interest of many who are involved in emergency care.

1.3 INTERFACES

Perhaps more than any other specialty, emergency medicine interfaces with outside agencies and specialties; management is always based on a team approach to care. The emergency medical system interfaces with police, firefighters, news media, transportation authorities, disaster planning agencies etc. Within the emergency department, patient care is provided by a team of professionals, including nursing staff, radiographers, pharmacists, blood bank and clinical laboratory personnel, social workers etc. The emergency doctor must rely on medical colleagues for consultation, post admission care, and post discharge follow-up care. The overall orchestration of personnel and resources for the immediate care of acutely ill or injured patients is the responsibility of the emergency doctor, until the evaluation shows that the patient can be formally transferred to another physician or service.

1.4 PREHOSPITAL CARE

Outside of the hospital situation, there is a clear organizational hierachy

- The police are in overall control of the situation.
- The fire service is in control of rescue and extrication
- The ambulance service is responsible for evacuation of casualties
- The medical team is present at the request of the ambulance team

Entrapment of casualties is now the most common reason for paramedics to request the assistance of a medical team - either prolonged entrapment or situations where analgesia is required.

An on site medical team must be formed from experienced staff who have high visibility protective clothing, adequate equipment and insurance for this type of work. However this is not always possible in rural and other underserviced areas.

A recent concept that is believed to improve overall outcome during disasters is the Incident Command System. Such a system is based on the philosophy that various sectors (triage, communications, transportation) are under the command of a single authority that can provide adequate control. The purpose of such a system is to reduce the amount of time and precious resources wasted on patients who do not need them (minor injuries) or will not benefit from them (victims of unsurvivable injuries, given the setting). The incident command system provides a structure that can prevent the misuse of resources (such as transporting patients before triage occurs).

Triage means "to sort". Although numerous systems exist for triaging accident victims, the basic concept identifies four groups of patients:

a) minor illness or injury (walking wounded)

b) serious but not life threatening illness or injury (such as a patient with intra abdominal injury who is currently not in shock)

c) critical or immediately life threatening illness or injury

d) dead or unsalvageable. The actual categorization is different in various types and magnitudes of disaster. Thus a critically injured patient who might receive the benefit of a comprehensive life saving effort in a three patient incident might be deemed unsalvageable in a disaster with a thousand victims.

The quality of medical care is directly related to the experience of personnel. A disaster has been defined as "many people trying to do quickly what they do not ordinarily do in an environment with which they are familiar". No matter how experienced an individual is, the level of care, resources available, and entire framework for resource management undergo major alterations during a disaster. Thus the development of a clear plan for the management of multiple casualties is imperative to ensure optimal outcome for the victims, given the resources available. Disaster planning must not be seen in a vacuum, but rather must include relevant agencies within the community, such as police and fire departments, ambulance team, communications and hospitals. No matter how well prepared a trauma centre might be to care for multiple casualties, if the transportation of disaster victims is disrupted or misdirected, patient outcome is adversely affected.

The only measures that have been shown conclusively to save lives in the pre-hospital situation are **ABC**:

Airway	Clearance, maintenance and protection
Breathing	Oxygenation and ventilation
Circulation	Chest compression and defibrillation

Extensive clinical examination and the establishment of IV infusions are of no proven benefit. However, other pre-hospital treatments may contribute greatly to the relief of pain and suffering.

Time at the scene must not be extended by anything other than essential treatment. The priority is to get the patient to the hospital as soon as possible.

The basic principles of pre-hospital care are the same as those for in hospital care. Specific resuscitation courses are now available where the applied skills may be mastered.

The general practitioner is sometimes called away by patients, relatives, nurses, police or others to attend to emergencies. The lay concept of what constitutes an emergency includes not only physical problems, but also emotional and social. The general practitioner needs to understand the patient's feeling of urgency and reassurance may not always be simple, but can require great skill and understanding. Despite this, the general practitioner must be available and organized to cope with the medically defined emergency when it comes. Emergency care outside the hospital represents one of the most interesting and rewarding areas of medical practice. City doctors will have to modify their degree of availability, equipment and skills according to paramedical emergency services, while others, especially remote doctors, will need total expertise and equipment to provide optimal circumstances to save patients lives.

1.5 GENERAL APPROACH TO THE EMERGENCY PATIENT

1.5.1 Initial priorities

The conventional approach to patient problems involves taking a careful history, performing a careful examination and obtaining laboratory, radiological and other diagnostic results to lead to proof of a specific diagnosis. This approach does not work well in the emergency department, because the immediate problem does not involve achieving a specific disease diagnosis but rather influencing a final common pathway of patho-physiological derangement that may be identical for many different diseases. For example, respiratory failure is no different if caused by pneumonia, or fatigue in a patient with asthma. The emergency physician should make a diagnosis if possible and if helpful, but the emergency team has more important priorities than establishing a precise diagnosis.

The first responsibility is to determine which emergency patient is most ill. Patients must be assessed by someone who is not only skilled in the recognition of serious but subtle illnesses, but who also has the capacity to avoid becoming involved with the details of care. This assessment has become known as TRIAGE.

The next step is to assign the patient to a physical location within the department. Emergency personnel must learn and relearn that placing the patient in a room usually assigned to trivial problems does not mean that the patient cannot harbour serious disease. Unfortunately, once a problem is labelled as trivial, re-thinking the case in a more serious fashion is difficult. However, each member of the emergency department must constantly reassess patients to acquire more than one point on the curve of their illness.

The following is an example of a Triage Scale:

CATEGORY	DESCRIPTION	TO BE SEEN BY DOCTOR WITHIN
1	Resuscitation	Immediately
2	Emergency	10 minutes
3	Urgent	30 minutes
4	Semi-urgent	60 minutes
5	Non-Urgent	2 hours

Three components are necessary for triage and identification of the life-threatened patient.

a) A chief complaint

b) A complete set of vital signs in the field and in the emergency department

c) An opportunity to visualize, touch, and auscultate the patient

The chief complaint, which sometimes cannot be obtained directly from the patient but must be obtained from family members and others, will help categorize the general type of problem (e.g. cardiac, traumatic, respiratory etc).

Vital signs are the most reliable, objective data that are immediately available to emergency department personnel. Vital signs and the chief complaint, when used as triage tools, will identify the majority of life threatened patients. It is essential to be totally familiar with normal vital signs for all age groups. Age, underlying physical condition, medical problems and current medications (e.g. beta blockers) are important considerations in determining normal vital signs for a patient. For example, a well conditioned young athlete who has just sustained major trauma and arrives with a resting, supine pulse of 80 must be presumed to have significant blood loss because his normal pulse is probably in the 40-50 range.

Most pre-hospital care systems with a level of care beyond basic transport also provide therapy to patients. Because this therapy usually makes positive changes to the patient's condition, the patient may look deceptively well on arrival in the emergency department. For example, a 20 year old female with acute onset of left lower quadrant abdominal pain, who is found to be cool and clammy, with a pule rate of 116 and a blood pressure of 78 palpable and who receives 1500 cc of fluid en route to the emergency department, may arrive with normal vital signs and no skin changes. If one does not read or pay attention to the paramedic's description of the patient and the initial vital signs, the presumption could be made that all is well.

Sometimes normal vital signs are not normal. For example, a 20 year old asthmatic patient has a respiratory rate of 14. An asthmatic patient who is dyspnoeic and wheezing

should have a respiratory rate of at least 20-30/min. The "normal" respiratory rate of 14 in this setting indicates that the patient is in respiratory failure. This is a classic example of where normal is not normal.

Visualizing, touching and auscultating helps to identify the threat to life i.e. is it the upper airway, lower airway or circulation? Touching the skin is important to determine whether shock is associated with vasoconstriction (hypovolaemic or cardiogenic) or with vasodilatation (septic, neurogenic or anaphylactic). Auscultation will identify threats associated with lower airway (eg. bronchospasm, tension peumothorax).

In conclusion, obtain the vital signs on every patient without exception. It cannot be stressed enough the need for accurate temperature determination especially in young children. Doctors often overlook temperature determination in adults, resulting in delay in perceiving the magnitude of problems or in beginning appropriate interventions. It is difficult to understand why so many doctors pay little attention to vital signs and then face the unhappy task of trying to explain away abnormalities that should have provided clues to the seriousness of the patient's problems. Although a patient can be seriously ill with what appears to be normal vital signs and may not be seriously ill with abnormalities of the same, it is best to believe abnormal vital signs in patients who appear ill, because changes in vital signs may provide clues to worsening in a patient's condition.

1.5.2 Key questions

1.5.2.1 WHAT IS THE THREAT TO LIFE?

Perhaps the most important principle of emergency medicine is to search for and assume that the most potentially serious problem for each patient may be present, even if it is statistically improbable. Thus the key question will lead you away from an untimely focus on diagnosis. This question is: **What is the threat to life?** Always ask: are there any life threats, and am I missing something? For example, if a patient comes to the emergency department with chest pain, you should attempt to prevent a cardiac arrest, extension of the infarction, or worsening of the patient's disease instead of ordering an immediate ECG to prove the diagnosis of myocardial infarction. Thus your first response must be to place an intravenous line, start the patient on oxygen and consider anti arrhythmic drugs before proving or disproving the diagnosis.

1.5.2.2 DOES THE PATIENT NEED ADMISSION?

The second key question is: does the patient need admission? If you start with the perception that the patient is very ill, not only do you increase the diligence of the search for a cause, but you are also prevented from reaching through tunnel vision for a specific diagnosis that may in fact be incorrect. For example, a patient may look nearly normal after receiving intravenous fluids, but if the patient was in shock in the pre-hospital setting, more time will be needed to recover than you can arrange in the emergency department. Moreover you need to communicate to the physician who will be responsible for the in patient care of the patient, the perception that the patient is truly ill.

1.5.2.3 CAN THE DIAGNOSIS BE SUPPORTED BY THE EVIDENCE AVAILABLE?

One normal ECG tracing does not eliminate the diagnosis of an acute myocardial infarction, nor does a normal white cell count rule out a diagnosis of appendicitis. Can you prove what you believe the patient has, or will the diagnosis require other tests that are not available within the emergency department? For instance, more than one patient has been diagnosed as having reflux oesophagitis as an explanation for the "indigestion", that was actually a reflection of an inferior myocardial infarction. A barium swallow

upper GI Xray study is not readily available in most emergency departments, but an ECG is. Also surprisingly common are cases in which all the evidence to support a serious diagnosis and mandate admission is present, but is ignored in favour of a trivial diagnosis that cannot be supported by, but is compatible with the discharge of the patient. An example is sending the patient home with a diagnosis of gastroenteritis when the patient has no nausea, vomiting or diarrhoea but does have a tender abdomen and absent or diminished bowel sounds and is in the age group most common for appendicitis.

1.5.2.4 WHAT IS THE MOST SERIOUS DIAGNOSIS?

What is the most serious diagnosis that could apply to the patient's condition, and have I ruled it out? Many doctors appear to have an unwillingness to recognize serious disease, but unless they constantly search for it, it will never be found. Many patients are much sicker than they initially appear, which deceives even experienced physicians who are used to seeing patients late in the course of their disease rather than early on. Wishing that bad diseases do not occur in anyone is human nature, but the ability to be suspicious is integral to the safe and effective practice of emergency medicine.

1.5.2.5 HAVE I ARRANGED A SATISFACTORY DISPOSITION?

In no other phase of medicine is it so critical to consider the circumstances under which a patient's disease is going to evolve and to obtain more than one point on a curve to determine if a patient is getting better or worse. Physicians sometimes make a definitive diagnosis in circumstances where it would be preferable to beg the question and see the patient again after some time. At this point many disasters in emergency medicine would be avoided. To either arrange to see the patient again personally or to ensure that the patient is seen by a consultant the next morning, or to keep the patient under observation prevents the all too common occurrence of the patient being sent back home to die or decompensate with a terrible outcome.

Many times the diagnosis, management and predicted outcome of a disease state is foiled by the failure to provide a satisfactory disposition: for example, sending a child with a fracture caused by non accidental trauma back to the same environment that produced it in the first place. This example may see to be extreme, but it occurs because the physician either does not recognize the child abuse or is content to report it to an appropriate agency and not pursue the next step of trying to address the environment.

Doctors also have difficulty using a hospital environment for something other than sophisticated diagnosis and treatment. This has been compounded by the health planners, insurance planners, and restrictions on admission. However, some patients need the help of a hospital to recover, and we must overcome our reluctance to do this for sociological reasons. One may be able to prescribe adequate analgesia for an elderly patient with a stable pelvic fracture, but if that patient lives alone and must climb the stairs, discharge is not going to be a satisfactory disposition for the patient. Similarly, a young adult can usually recover from pneumonia when treated as an outpatient, but if that patient is a mother with three young children, she will not have any rest without being placed in hospital.

1.5.2.6 HAVE I PERFORMED A PERTINENT AND THOROUGH WORKUP?

Along with getting fooled by the early subtleties of disease, doctors tend to take short cuts when they become busy in the emergency department. You may conclude that the patient is not seriously ill and neglect to perform the rectal or pelvic examination that would provide useful information and perhaps steer you in the direction. You cannot practice perfect medicine, but if you use safe diligence, rarely will a problem remain unrecognized and unidentified.

1.5.2.7 WHY IS THE PATIENT HERE? HAVE I MADE HIM OR HER FEEL BETTER?

Many patients overestimate the magnitude of their illness, but more commonly, many people underestimate the magnitude of their problems. The frustration of trying to deal with illness during the day may drive some people to seek attention at night. No emergency department is without inconvenience, pain and expense, and to be there means one has a need requiring attention. We as doctors should understand that most patients would prefer to be somewhere other than in an emergency department.

Many times doctors may be content with making a diagnosis such as viral syndrome and forget that knowing what is wrong does not necessarily help patients to feel better. Instead doctors should ask if I can lower a temperature, restore some fluids, relieve pain, and provide reassurance? These things are often overlooked in the pressure to "treat and street patients".

With inpatient services, physicians spend much less time with individual patients than do nurses, and in general are unaware that a large part of recovery from any illness is independent of invasive procedures. Doctors are sometimes fooled by subjective improvements in the patients' conditions. It is well known that a ruptured appendix may cause relief from the intense agony experienced while the appendix was under bursting pressure. The patient may therefore describe a feeling of subjective improvement, but objective findings will not support this. Have the patient's vital signs improved, have the positive physical findings that were so well described by the triage nurse on the initial examination improved, is there an explanation as to why the patient is better?

1.5.2.8 WAS I ANGRY WHEN I MADE MY DECISION?

Anger is an emotion that almost always guarantees faulty decision making. It is therefore wise to understand the cause of anger before committing the patient to a final disposition. At times anger originates from personal life circumstances rather than the professional workplace. Sometimes an irritating colleague inspires anger, sometimes patients themselves are angry or provoke anger. You do not need to like a patient to deliver professional and competent care, but you must rid yourself of anger and frustration to accomplish this. Learn to reserve judgement on the patients in the emergency room.

1.5.2.9 DOES THE CHART REFLECT MY THINKING?

Charting and writing progress note on patients is an essential component of emergency care.

The purpose of charting is to provide points on the curve that measure the natural history of the patient's disease. If a single measurement has been taken, a prediction of the shape and slope of the curve can be made. The emergency department record is not the lengthy text of the medical student's internal medicine work up. It is terse and pointed and contains important negatives and positives. The best way to remember what is important is to ask 'what am I seeing, and am I communicating this to someone else in the future?' For example in the infant with diarrhoea, how can one indicate the state of hydration without describing the general appearance of the baby, the presence or absence of tears, diaper wetting, skin turgor, fontanelle appearance and mucous membrane moisture? This description does not take much space or time, and when combined with the number of stools will assist in assessing the degree of hydration, and the need for admission.

An error that many physicians fall into is to list every possible item in a differential diagnosis, to be "complete". List only those significant diseases that must be considered, as well as how you ruled them out in your mind. Only in this way can you draw a reasonable picture of what you are seeing and thinking.

1.5.2.10 DEALING WITH GRIEF

One of the responsibilities that the emergency physician finds the most difficult is dealing with the grief that is constantly being generated by the difficult problems of emergency medicine. Each specialty has its own unique failures, but for emergency medicine it almost certainly is the sense of failure that develops when the physician is not capable of preventing death. Physicians are so conditioned to thinking that because they can prevent some untimely deaths, they can prevent all deaths. Therefore they may think that the failure to do so is attributed to poor practice, lack of knowledge or weaknesses of the team.

Physicians also are not taught to manage grief properly, and therefore the task is uncomfortable. They tend to avoid it by saying they are too busy or that it is the job of the pastors, social workers, nurses, or anyone other than themselves.

However, emergency physicians do have the responsibility and they can ensure that the grieving process will be healthy if they approach it correctly. If they shun the responsibility, not only do they increase the risks of making the grieving process a pathologic one, but also increase their own sense of failure, raise the prospects that their care will be held responsible for the outcome, and produce problems where they need not exist.

Many people will not believe the details of care, nor will they have an ability to form a realistic impression of how their relative or friend has died if they have not talked to the physician involved in the care. The suddenness of the illness, the lack of prior contact with the emergency staff and the emotional turmoil of needing to deal with sudden, undesired and intense loss conspire to produce a delicate balance between sadness and rage. The balance can too easily shift towards rage when the process is not understood or dealt with effectively.

The emergency physician's first responsibility is to come to terms with ones own mortality. This task is much easier for older physicians who may have experienced serious personal disease. The younger person who cannot conceive of personal mortality is much less willing to accept the reality that not all death is preventable with appropriate medical care. Many gravely ill or injured patients are being brought to the emergency department in a critical state due to improvements in pre-hospital care and the rapid transport times now being achieved. They have not completed the act of dying, and because they appear to be serious but salvageable, much anger and guilt can be induced in the emergency staff.

Each physician has particular areas of emotional vulnerability; for some it may be mutilating injury, for others death in childhood. Whatever your vulnerabilities, you can be sure to encounter them in a busy emergency department. It does help to think about those problems; to realize that other members of the team are probably experiencing similar feelings; and to realize that the hardened, cynical, apparently sophisticated façade that the more experienced members of the team seem to possess is probably a defence against emotions that threaten to be overwhelming.

If time permits, discuss emotionally troublesome cases, as well as medically difficult ones among personnel. It is sad that more emergency departments do not have a structure that permits such discussion on a regular basis.

Attempt to lessen the psychic pain of relatives or friends during a resuscitation attempt, by either the nurse or the doctor explaining the gravity of the situation whilst the attempted resuscitation is going on. Even if the relatives cannot be reached until after the event, attempt to prepare them by saying " I have some very bad news for you". Even a few moments of preparation is better than nothing. If possible, try not to inform relatives over the telephone. There is no good way to attenuate the pain other than to be direct and clear in the communication.

The experience of grief never appears to be absent, even when the patient has died from a long-term and very debilitating illness. It appears to be an almost universal human response to death.

One of the additional emotional responses to death is guilt. We often think that if we had just taken an appropriate action, we could have prevented this from happening. Deal directly with this guilt so that it will not become misdirected to other members of the family or the emergency personnel. Where doubt about guilt exists, such as in suspected child abuse, it is advisable to be non-judgmental as the emergency team rarely knows all the circumstances. Tailor the facts to each situation.

Guilt may be replaced by anger in certain circumstances and this may be misinterpreted by emergency personnel. By not understanding and by reacting negatively to the anger, the physician or nurse may cause the relative's grief and anger to be directed towards themselves. Help the relatives express their anger by allowing some time for ventilation and by carefully reinforcing that medical tasks were carried out appropriately.

In most cases, the relatives will wish to view the body, which should be done after cleaning up some of the mess of the attempted resuscitation.

Regarding the issue of sedatives for grieving persons: these generally prolong the grieving process.

There is no "normal" response to grief; some people will experience insomnia, some sleep more; some are anorectic, others experience great hunger. If sedatives are given, these should generally be for a short duration only. The relatives should always have a contact person to whom they can go to for any major psychological problem thereafter. Relatives often express a fear that a relative who is not present is "too ill" to hear bad news. Offer to break the news and inform the relatives that one cannot hide a death forever.

1.6 PRINCIPLES AND PRIORITIES IN EMERGENCY MEDICINE

The ABC (airway, breathing and circulation) of emergency medicine can be modified and adapted according to the specific clinical scenario and circumstance of each individual case. Critically ill patients should be assigned to a triage category of either 1 or 2, meaning that these patients should be either seen immediately or within 10 minutes.

The approach to seriously ill patients can be simplified by considering the following **four scenarios**. Note that there is considerable overlap in the assessment and management of these patient scenarios, but it is nevertheless useful to consider and present each group separately.

A) Cardiac Arrest in Adults - Basic and Advanced Cardiac Life Support (ACLS)

B) Assessment and Management of the Severely Injured Patient - Acute Trauma Life Support (ATLS)

C) Assessment and Management of the Seriously Ill Adult Patient
(Eg. Asthma, Pneumonia, Status Epilepticus etc)

D) 1. Assessment and Management of the Critically Ill or Injured Child - Paediatric Advanced Life Support, Acute Paediatric Life Support (PALS, APLS)

2. Resuscitation of the Newborn

We will now outline the general approach to each of the above.

1.6.1 Cardiac Arrest in Adults - Basic and Advanced Life Support (ACLS)

Emergency cardiac medicine teaches a familiar and simple approach: **primary survey followed by secondary survey.** This approach provides a wonderful conceptual tool for the acute cardiac life support provider to use when approaching cardiac emergencies.

THE PRIMARY SURVEY

First ABCD

In the primary survey, focus on basic CPR and defibrillation.

Airway

Open the airway

Breathing

Provide positive pressure ventilation

Circulation

Give chest compressions

Defibrillation

Shock VF/ pulseless VT

SECONDARY SURVEY

Second ABCD

Airway

Establish advanced airway control
Perform endotracheal intubation

Breathing

Assess the adequacy of ventilation via endotracheal tube
Provide positive pressure ventilations

Circulation

Obtain IV access to administer fluids and medications
Continue CPR
Provide rhythm appropriate cardiovascular medication

Differential Diagnosis

Identify the possible reasons for the arrest. Construct a differential diagnosis to identify reversible causes requiring specific treatment.

1.6.1.1 CARDIAC ARREST IN ADULTS

ASSESSMENT

Hazards? - Ensure the safety of the rescuer and the victim.

Hello - Check for responsiveness by tapping and talking to the victim.

Help! - If patient unresponsive, call for assistance

CARDIO - PULMONARY RESUSCITATION (CPR)

A. Airway

1. Open the airway by lifting the bony part of the chin with the fingers of one hand, while placing the other hand on the patient's forehead and tilting the

head backwards (head tilt chin-lift manoeuvre). This will lift the jaw and the tongue off the posterior pharyngeal wall, opening the airway.

2. Remove vomitus/foreign bodies from the mouth if present
3. Remove dentures only if they cannot be managed into place

NB. Do **not** tilt the head backwards if a neck injury is suspected - instead place fingers behind the jaw on each side and pull the jaw forwards while opening the mouth with your thumbs (Jaw Thrust Manoeuvre).

B. Breathing

1. While keeping the airway open, assess if patient is breathing by placing your ear next to the patient's mouth and **look, listen and feel** for up to 10 seconds for evidence of movement. If the patient is breathing, place in the **recovery position.**
2. If patient is not breathing, send for help (and for a defibrillator) and administer 2 effective breaths. Then assess for signs of circulation. Take up to 10 seconds to check for any movement, swallowing or carotid circulation. If a pulse is present, administer one effective breath every 5 seconds (12/min).
3. For mouth to mouth ventilation, keep the airway open and pinch the nose closed using the hand which is on the patient's forehead. Ensure that the chest wall rises. If a mouth to mouth mask device is available, this should be used. Place the device between the patient's teeth. Lift the jaw forwards while keeping the nostrils closed and form a tight mouth to mouth seal over the device. Ensure that the chest rises with each breath given.
4. **Mouth to nose ventilation** may be indicated in the presence of trismus, mouth injuries, or if firm mouth to mouth seal is difficult to obtain.
5. If a face mask is being used for ventilation, a tight seal around the mouth and nose is mandatory while keeping the airway open with the jaw thrust manoeuvre. If the correct size oropharyngeal tube is available, this may be inserted.

C. Circulation

1. If a pulse is **absent,** start chest compressions before a **defibrillator** becomes available.
2. A single **precordial thump** is indicated if no pulse is detected in cardiac arrest, which is **witnessed**, before defibrillation.
3. Until the defibrillator arrives, after giving 2 patient ventilations, compress the sternum using the heel of both hands (one on top of the other) placed 2 finger breaths above the ziphisternum. Keep your elbows straight, and shoulders directly above your hands. The patient must be on a firm surface.
4. **If alone,** compress sternum 15 times to a depth of 4-5 cm at a rate of 100/min (about 2 compressions per second) then return to airway opening, giving 2 breaths, 15 compressions repeatedly.
5. **If 2 rescuers are present,**, one rescuer compresses the chest, while the other rescuer gives 2 breaths after every 15 compressions. Pause for the ventilation unless the patient is intubated.

NB. Never interrupt CPR for more than 10 seconds (unless intubating or defibrillating).

D. Defibrillation

1. Ventricular fibrillation is the most common mechanism of acute cardiac arrest in adults. Therefor **the sooner the patient is defibrillated,** the greater the chance of successful resuscitation.
2. The moment the defibrillator arrives, lubricate paddles with electrode paste, (or place special defibrillation pads on chest), stop CPR and place one paddle to the right of the sternum just below the right clavicle and the other paddle over the left lower ribs in the mid-axillary line. Look at ECG on monitor (**quick look paddles).**
3. If ventricular fibrillation is present and there are no signs of circulation, **immediately** administer a 200 joule unsynchronized shock (ensure that the " synch" button, if present, is switched **OFF**). If ventricular fibrillation persists, immediately repeat with another 200 J shock. If ventricular fibrillation persists, repeat with 360 J (i.e. **3 shocks are administered rapidly and consecutively,** checking monitor screen for persistent ventricular fibrillation before each shock).
4. If no pulse returns after 3 shocks, continue or start CPR, **intubate**, set up a large bore **IV line** and administer **drugs** as described below. Look for and correct reversible causes of cardiac arrest.
5. Defibrillate (3 shocks of 360) after **every minute** of CPR if venticular fibrillation persists.

E. Endotracheal intubation and initial drug therapy

1. Intubate the trachea as soon as possible if competent to do so.
2. Always oxygenate lungs well before intubating.
3. Intubate using a **7.0 or 8.0** endotracheal tube in adults.
4. If more than one attempt required, oxygenate and ventilate patient adequately between attempts. (do not take more than 30 seconds per attempt).
5. **Adrenaline**, is indicated in all cardiac arrests not responding to initial resuscitation/defibrillation. Give 1 ml of 1:1000 solution IV stat (or 2ml of 1:1000 solution via ET tube if no IV line available yet - dilute 2ml of 1:1000 solution with 8ml of sterile saline). Repeat every 3 minutes during resuscitation.

F. Further Management according to ECG response

1. Ventricular fibrillation (and pulseless ventricular tachycardia)

Defibrillate - immediately (200 -200-360J) if no sign of circulation. If no pulse returns, do 1 min of CPR, and repeat 3 shocks at 360J after every minute of CPR if ventricular fibrillation/pulseless VT persists.

Adrenaline - if initial 3 defibrillation shocks unsuccessful, repeat using 1mg every 3 minutes during CPR.

Amiodarone - 300mg bolus followed with 20ml dextrose water flush (not normal saline), given after the first IV dose of adrenaline following the second set of shocks if VF/VT persists.

An additional dose of 150mg may be given after 3-5 mins if VF/VT persists.

After return of spontaneous circulation, a loading dose of 360mg may be administered over 6 hours at a rate of 1 mg/min.

Thereafter, a maintenance infusion of 540mg is administered over 18 hours at a rate of 0.5mg/min (maximum dose - 2.2g/24 hours).

Lignocaine - 1 mg/kg stat only if Amiodarone is not available. Repeat every 3-5 min if necessary (maximum total dose 3mg/kg).

Magnesium - 1-2g stat if above unsuccessful or if hypomagnesaemia or torsades de pointes is suspected.

Bicarbonate - 1ml/kg of 8.5% solution IV after 20 minutes, or sooner if hyperkalaemia or metabolic acidosis is present.

Always look for and correct reversible causes of cardiac arrest.

2. Non VF/VT (Pulseless electrical activity and Asystole)
(QRS complexes or straight line on ECG and no pulses detectable)

- Continue CPR
- Look for and **correct reversible causes**, especially hypoxia, hypovolaemia, hypothermia, acidosis, tension pneumothorax, cardiac tamponade, pulmonary embolism, toxins and drug overdoses.
- Check that the **electrode and/or paddle positions** and contact is optimal
- Give **Adrenaline** -1mg every 3 minutes during CPR
- Give **Atropine** -1mg IV every 3 min if bradycardia or asystole - up to 3 mg
- Consider **Bicarbonate** -1ml/kg of 8,5% IV if indicated (eg hyperkalaemia/metabolic acidosis)
- Consider **Pacing** if the arrest was witnessed and there is evidence of some electrical activity.

G. General Comments

1. The best success rates are achieved when CPR commences within 4 minutes of arrest, and advanced life support is started within 8 min of arrest.
2. Defibrillate as soon as a defibrillator becomes available. Check for the absence of pulse before defibrillating.
3. Adrenaline can be administered via the ET tube until an IV line is available - inject twice the normal IV dose (dilute 2ml with 8ml normal saline).
4. Avoid intracardiac adrenaline if possible (except as a last resort)
5. Dilated pupils may be due to drugs, hypothermia, snakebite etc, and therefore does not necessarily indicate brain damage.

BASIC AND ADVANCED LIFE SUPPORT ALGORITHM FROM THE RESUSCITATION COUNCIL OF SOUTH AFRICA

Universal Basic Life Support Algorithm

If victim appears to be in need of help, adopt a **SAFE** approach:
S = Shout for assistance
Hazards? A = Approach with care
F = Free from dangers
E = Evaluate the victim

Hello?
Check responsiveness by tapping and talking to victim

Responsive

If safe to do so:
- Keep victim in position found
- Treat illnesses or injuries as necessary
- Get help if needed
- Reassess continuously until help arrives

Unresponsive

Help!
Call for Assistance

If unresponsive:
- Shout loudly for help if alone
- Ask a bystander to wait for you to assess the victim

A

Open Airway
Head tilt – chin lift

If neck injury is suspected:
- Avoid head tilt
- Do chin lift or jaw thrust

Assess Breathing
Look, listen and feel for up to 10 seconds

Breathing present

If breathing (more than an occasional gasp):
- Place in recovery position
- Check for continued breathing
- Send or go for help
- Reassess continuously until help arrives

Send or go for Help if not Breathing*

B

Breathe
Administer 2 effective breaths

If difficulty with breathing:
- Remove obvious obstructions from mouth
- Ensure adequate head tilt-chin lift
- Make up to five attempts if necessary

Assess Circulation
Check for movement/pulse for up to 10 seconds

Circulation present

If signs of circulation present:
- Continue rescue breathing
- Assess circulation every minute
- Place in recovery position if breathing returns.
- Reassess continuously until help arrives

No circulation

Shoulders directly above sternum

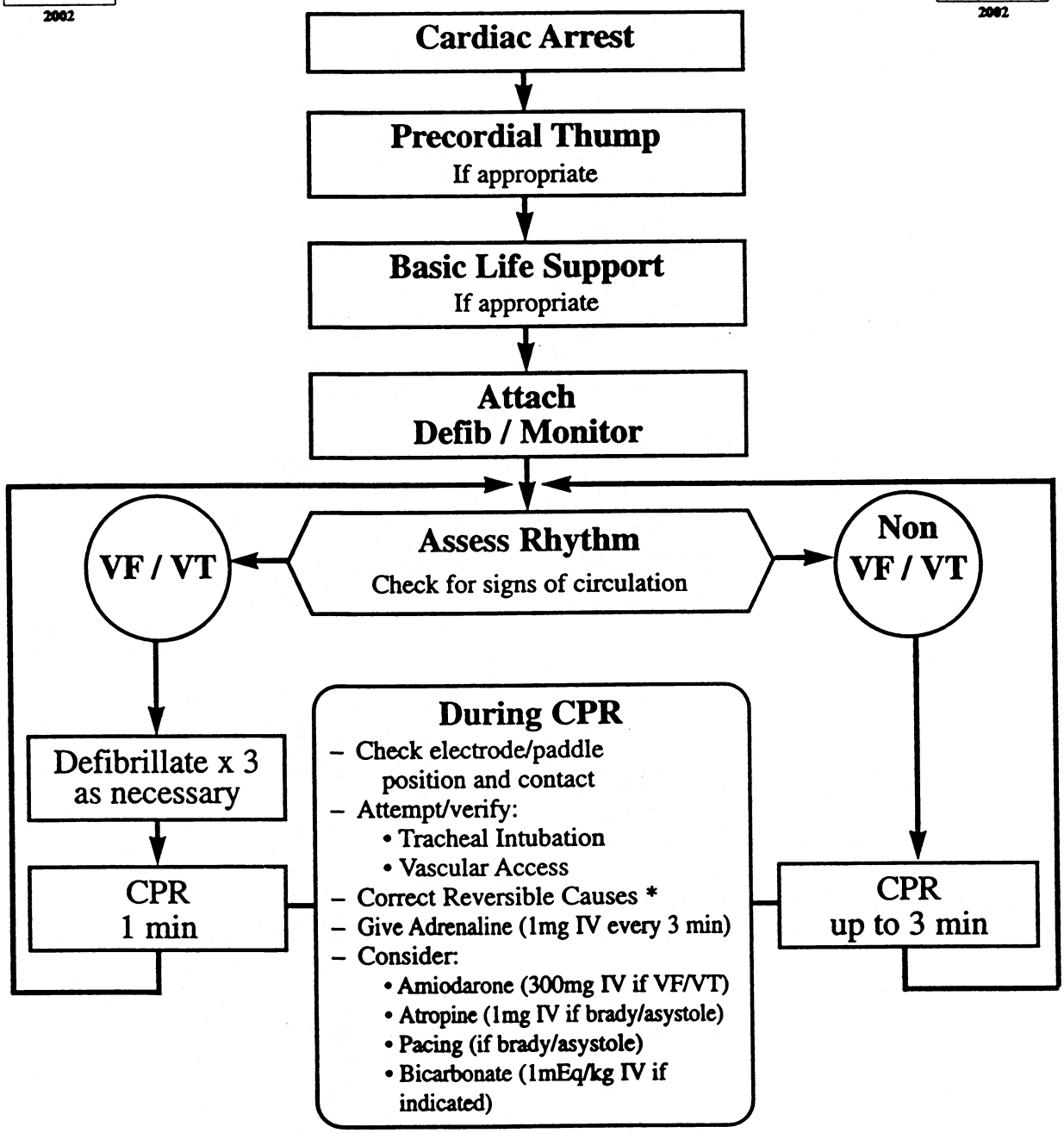
C

Compress Chest
100/minute (almost 2 compressions/second)

Adult:	Children:
15 compressions followed by 2 effective breaths	5 compressions followed by 1 effective breath

* If you are on your own:
- Perform one minute of CPR before going for help if the victim is an infant or child, or if the likely cause is drowning or trauma
- Go for help before starting breathing for all non-trauma adults who have not drowned
- Continue CPR until signs of life or qualified help arrives

UNIVERSAL ADVANCED LIFE SUPPORT ALGORITHM



* Correct Reversible Causes:

Hypoxia	Test other pulses
Hypovolaemia	Tension pneumothorax
H^+-acidosis	Tamponade
Hyper/Hypokalaemia & metabolic disorders	Toxins
	Therapeutic disorders
Hypothermia	Thrombo-embolic/ mechanical obstruction
Heart attack	

The algorithm is based on the assumption that the previous step was unsuccessful

1.6.2 Assessment and Management of the Seriously Injured Patient

1.6.2.1 ACUTE TRAUMA LIFE SUPPORT (ATLS)

A regulated and planned approach to the seriously injured trauma patient is presented, using the ATLS guidelines.

PRIMARY SURVEY AND RESUSCITATION

A. Airway and Cervical Spine

The airway may be:

- patent, partially obstructed, or completely obstructed (this may result from physical obstruction or loss of muscle tone)
- adequately protected or at risk

Check for responsiveness

Is the patient alert and responsive to questions? A verbal reply confirms that there is:

- a maintained and protected airway
- temporary adequate breathing and circulation
- cerebral functioning

Look listen and feel for breathing

The absence of breath sounds indicates the need to attempt airway opening manoeuvres, and if unsuccessful to consider the possibility of airway obstruction.

Look for signs of partial upper airway obstruction

- Snoring - the familiar sound of obstruction caused by the soft tissues of the mouth and pharynx. It often accompanies the reduced muscle tone of a lowered level of consciousness.
- Rattling or gurgling - the sound of fluids in the upper airway.
- Stridor - a harsh crowing sound best heard on inspiration. Stridor suggests obstruction at the level of the larynx and upper trachea.
- Drooling - the inability to swallow saliva. It suggests blockage at the back of the throat.
- Hoarseness - gross voice change. This also suggests obstruction at the level of the larynx.

Management

The possibility of an injury of the cervical spine should be suspected in all patients with a significant history of trauma. In these cases no airway manoeuvres should involve movement of the neck. Immediate manual cervical spine immobilisation should be done by a designated team member until the primary survey has been completed and an immobilizing device can be applied.

A rigid cervical collar can be applied to assist with spinal immobilisation but it should not delay the management of the airway. The cervical collar alone does not provide complete stabilisation of the cervical spine.

The stepped airway protocol is followed if any signs of a compromised airway are present. The aim is to open and improve, and then to establish and secure.

- The mouth is opened and the oral cavity inspected (chin lift / jaw thrust manoeuvre). Any visible foreign objects must be removed (finger sweep, Magill's forceps). If any secretions or blood are present, rapid controlled suctioning with a rigid suctioning tip is performed under direct vision.
- This is followed by placement of an oropharyngeal tube, if a gag reflex is absent. This is a temporary measure, while the intubation equipment is prepared.
- Endotracheal intubation :

  This is the gold standard for definitive airway management.

  An assistant should apply in line cervical spine immobilisation, preferably from the caudal position.

  Pre-oxygenation with 100% oxygen is performed for 2-3 minutes.

  Cricoid pressure is applied during manual ventilation.

  A pulse oximeter is used to monitor the patient.

  The time of intubation should not be longer than 30 seconds, the time of an average breath hold.

  It is important to replace the oropharyngeal tube in the mouth after endotracheal intubation to prevent the patient from biting the tube.

  The position of the tube should always be checked personally, by auscultation, first over the epigastrium, then over the axillae.
- A surgical airway may be necessary if endotracheal intubation fails.

Oxygen.

All trauma patients must receive the highest possible oxygen concentration.

Risk of aspiration

All trauma patients should be presumed to have a full stomach. This, together with alcohol intoxication, increases the risk of vomiting and subsequent aspiration. It takes only one breath after vomiting to aspirate.

A rigid suctioning catheter should be at hand and the patient turned to the left lateral position if signs of vomiting appear. If this cannot be done safely and immediately, the head of the bed should be dropped 20 degrees and the vomit is suctioned from the mouth.

B. Breathing

This part of the examination should be done in a careful and systematic way, otherwise important information will be missed.

Inspection

- Rate, rhythm, depth, symmetry of breathing
- Loss of consciousness
- Colour - cyanosis
- Trachea - displaced

- Neck veins - distension in tension pneumothorax/cardiac tamponade
- Swelling around the neck - haematoma, surgical emphysema
- Accessory muscles - platysma, scaleni, intercostal, abdominal
- Chest wall - wounds, recession, airway obstruction, paradoxical movement, flail chest
- Abdomen - abdominal breathing, spinal injury between level C5 and T12, gastric distension splinting diaphragmatic movement.

Palpation

- Symmetry of movement - unequal, flail chest, pneumo/haemothorax
- Tenderness - rib fracture, flail chest
- Crepitus - displaced fractures
- Surgical emphysema - chest and neck

Percussion

- Dull - haemothorax
- Resonant - normal or pneumothorax
- Hyper-resonant - tension pneumothorax

Auscultation

- Air entry - always compare left with right (axillae more accurate than anterior chest because of less muscle and fewer transmitted sounds from large airways)
- Breath sounds - crepitations, rhonchi, wheezes, transmitted upper airway sounds
- Re-confirm placement of endotracheal tube

Factors which compromise breathing

- Central depression
- Airway obstruction
- Tension pneumothorax (diagnosis must be made clinically!): respiratory distress, tachycardia, distended neck veins, hyper-resonance and absent ipsilateral breath sounds, contralateral tracheal deviation, hypotension, pulsus paradoxus.
- Open chest wound - sucking wound especially if > 2/3 of tracheal diameter, preferential flow through wound
- Flail chest - two or more ribs fractured at two or more places
- Massive haemothorax - hypotension, decreased breath sounds, dullness to percussion
- Cardiac tamponade - hypotension, muffled heart sounds, tachycardia, pulsus paradoxus, distended neck veins (not visible if hypovolaemic)

A pulse oximeter is a useful guide during the assessment of breathing but it does not give a direct reflection of the partial pressure of oxygen in the blood : 100% oxygen saturation = PaO2 > 90 mm Hg, 95% = 70 mm Hg, 90% = 60 mm Hg.

Management

Detailed discussion of management will be discussed later in the module, only a brief outline will be presented here.

1. Airway obstruction - reassess airway
2. Apnoea or bradypnoea - rescue breathing should be instituted and definitive airway established.
3. Tension pneumothorax - treatment should not be delayed in order to confirm with chest x-ray. Immediately decompress with a 14 gauge cannula in the second intercostal space, midclavicular line.
4. Sucking chest wounds - should be immediately sealed off with an occlusive dressing on three sides, allowing air to escape from the pleural cavity (one way valve) in order to prevent a tension pneumothorax caused by air leaking from the underlying injured lung.
5. Flail chest - may be associated with significant underlying lung contusion and progressive hypoxia. The treatment is aimed at correcting the abnormality in chest movement and optimally ventilating the damaged lung tissue through intubation and positive pressure ventilation.
6. Cardiac tamponade - immediate needle pericardiocentesis can be attempted. Beware of false negative aspiration due to clotted blood. Urgent thoracotomy if required. Fluid resuscitation provides only temporary improvement.
7. Massive haemothorax - this is confirmed (during the secondary survey) by placement of an intercostal drainage tube and drainage of >1500 ml blood initially or >200 ml/hour. The placement of an intercostal tube does not resolve the emergency, but should be followed by an emergency thoracotomy. These patients are ideal candidates for autotransfusion. A massive haemothorax may not be obvious on a supine chest x-ray owing to blood spreading posterior to the lung.

C. Circulation and Haemorrhage Control

The **presence of a carotid pulse** should be checked for 5-10 seconds. The rate, rhythm and symmetry must be noted. The presence of tachycardia is one of the most sensitive indicators of early circulatory shock.

The location of **the most peripheral pulse** is a useful guide to the systolic blood pressure.

- radial pulse : systolic blood pressure (SPB) at least 80 mm Hg
- femoral pulse : SBP at least 70 mm Hg
- carotid pulse : SBP at least 60 mm Hg

The **presence of external bleeding** is determined

Signs of **circulatory shock** to be looked for:

- loss of consciousness
- respiratory rate : tachypnoea
- neck veins : distended - cardiac tamponade, tension pneumothorax

The following 4 signs are all indicative of **peripheral vasoconstriction**, one of the first compensatory mechanisms during circulatory shock.

Colour : central or peripheral pallor or cyanosis

Moisture : diaphoresis

Temperature : cool

Capillary refill : > 2 seconds

An ECG monitor and blood pressure recordings assist in the assessment of the above signs. Always treat the patient and not the monitor!

Blood loss can be expressed as a percentage of blood volume according to the following :

< 15 %

15-30%

30-40%

>40%

For possible sources of blood loss (one on the floor and four more)

- On the floor - history from paramedics
- In the chest - heart, great vessels or lung laceration: > 2 litres blood;
  - ribs: 100 to 200 ml each
- In the abdomen - aorta, inferior vena cava, liver or splenic injury : 2 litres
- In the pelvis - pelvic fracture: 1 - 3 litres.
- In the thigh - femur fracture: 1 - 2 litres
  - other long bones: 0.5 - 1 litres

Management

- **Control external haemorrhage:**
  - Direct pressure
  - Elevation
  - Pressure points (radial, brachial, femoral etc)
  - Mast suit of limited value in terminating arterial haemorrhage (inflated pressure 30-40 mm Hg)
- **Establish 2 large bore IV lines**

  14/16 cannula with high capacity administration set

  Compare: 14G - 125ml/min = 1 litre over 10 minutes
  18G - 35 ml/min = 1 litre over 30 minutes

  Peripheral lines are the first option with the least complications. Limbs with proximal long bone fractures must be excluded.

  In adults there are 3 alternatives if a peripheral site is not available or attempted unsuccessfully. **Venous cut-down** requires the correct equipment and can be time consuming if the practitioner is not experienced. **Central venous pressure lines** carry an increased risk of complications and require more experience. The addition of a pneumo or haemothorax

may further compromise the already traumatised patient. A large short bore cannula, which will allow faster infusion rates, should be used.

Femoral lines are of limited value for the purpose of drug administration during severe hypovolaemia or active resuscitation where there is minimal blood flow below the diaphragm. Femoral lines should also be used with caution when the inferior vena cava and iliac vessels may be compromised as a result of abdominal or pelvic injuries.

In children less than 6 years of age there is one alternative if a peripheral site is not available or unsuccessful, namely an intra-osseus line. The maximum flow rate is 40-50 ml/min through an intra-osseus needle. Proximal long bone fractures must be excluded.

Obtain blood **samples** for biochemistry, full blood count/haematocrit and cross match. Pregnancy testing must also be considered in a female patient of childbearing age.

- **How much fluid?**

  The traditional concept of "as much as possible as soon as possible" has fallen into disfavour. Hypotensive resuscitation (SBP - 90-100 mmHg) is becoming more popular owing to the fact that it decreases the gradient for blood loss and reduces the "blowing off" of clots from damaged blood vessels. Massive infusion of clear fluids will increase bleeding, cause haemodilution and disseminated intravascular coagulation (DIC). It can also cause hypothermia if not warmed to 40 degrees C.

  Fluid resuscitation has only limited value and should not delay surgical consultation and subsequent operative management to locate and terminate haemorrhage.

  If the patient is hypotensive, 1 litre crystalloid (Ringers, 0.9% saline) may be infused and the patient's response evaluated. If there is no response, another litre is infused while ordering O type blood. If there is no response after the second litre, colloids (starches, gelatines) may be considered until the blood arrives. If there is a transient response to the fluid therapy, there may be time to order type specific blood.

  Dextrose containing solutions have no place during fluid resuscitation. Less than 100 ml of each litre remains intravascular! Increased serum glucose concentrations may actually cause osmotic diuresis. Hyperglycaemia may aggravate head injuries.

  Adrenaline and other resuscitation drugs have very little place in hypovolaemic shock.

D. Disability and Neurological Evaluation

A brief neurological evaluation is performed and any evidence of neurological deficit or lateralising signs should be noted.

AVPU or Glasgow Coma Scale Score

The above are used in the assessment of level of consciousness. A patient with spinal injuries might not respond to pain stimuli owing to the absence of sensation at that level.

A	=	Alert
V	=	Responds to verbal stimuli
P	=	Responds to painful stimuli
U	=	Unresponsive

Pupillary size, equality and reaction

A unilateral dilated pupil indicates a focal intracranial mass lesion and necessitates urgent referral to a neurosurgeon.

E. Exposure and Environmental Control

The patient's clothes should be cut to provide exposure to enable further clinical examination to take place. Prevention of hypothermia is very important.

F. Resuscitation

Re evaluate :

a) Airway

b) Breathing/Ventilation/Oxygenation

c) Circulation

d) Urinary and Naso-gastric catheter

e) Monitoring:

- Ventilatory rate, arterial blood gases and end tidal CO2
- Pulse oximetry
- Blood pressure
- ECG

f) Xrays - chest, cervical spine and pelvis

g) Consider need for transfer

SECONDARY SURVEY

The secondary survey only commences after the primary survey has been completed and the resuscitation is well under way. It is a rapid but thorough physical examination for the purpose of identifying as many injuries as possible. However, it is important to note that if the patient's condition deteriorates, one must revert to the primary survey (ABC). The secondary survey should not delay definitive care.

Objectives of the secondary survey

- Reassessment of vital signs
- Detailed head to toe examination
- Complete medical examination
- Special investigations
- Assimilation of all the clinical, laboratory and radiological information
- Formulation of a management plan for the patient
- Clinical records for medicolegal purposes

a) History : (AMPLE)

- Allergies
- Medications
- Past History
- Last meal

- Events
- Blunt trauma
  - Penetrating injury
  - Burns or cold injury
  - Hazardous environment

b) Physical examination

- Head
- Maxillofacial
- Cervical spine and neck
- Chest
- Abdomen
- Perineum/Rectum/Vagina
- Musculoskeletal
- Neurological

c) Re-evaluation

d) Definitive Care

e) Three important Xrays

1.) Chest Radiography

Good radiographic technique is essential for producing good diagnostic chest Xrays.

- Exposure factors
  Looking through the heart on a PA film one should just be able to make out the architecture of the thoracic vertebrae. If these are seen too clearly, the film is over-penetrated, if not seen at all the film is under-penetrated, making it difficult to comment on the lungfields.
- Size and shape of the chest - exposures will vary according to the size and shape of the chest.
- Good inspiration - one should be able to visualize at least 11 ribs posteriorly above the diaphragm. Poor inspiration will result in difficulties in measuring heart size and assessing the lungs.
- Patient positioning - PA position is best. AP films will result in difficulties in assessing cardiac size and pulmonary vasculature. Check that patient is not rotated by checking that the medial edges of the clavicles and the spine are equidistant.

How to read a chest radiograph

1. Soft tissues : compare both sides. In females check for both breast shadows. Look for signs of surgical emphysema.
2. Skeleton: count all ribs and check for fractures. Check clavicles, scapulae, shoulders, thoracic and cervical spines.

3. Pleura. Check costophrenic angles for haemothorax. Check for pnemothorax.
4. Diaphragm : the right hemidiaphragm is 2cm superior to the left. Compare the shape and position. Look for free air under the diaphragm.
5. Mediastinum: check the position of the heart with two thirds of the transverse diameter of the heart to the left of the spine and one third to the right. In the superior mediastinum the trachea should be central. Check for widening of the superior mediastinum at the level of the aortic arch.

   Heart size is <50% off transthoracic diameter.
6. Hilar region : the left is 2cm superior to the right. Check position, contour and density.
7. Lungs : compare both sides. Divide the lungs into three zones: upper, middle and lower and compare both sides.

A few important points:

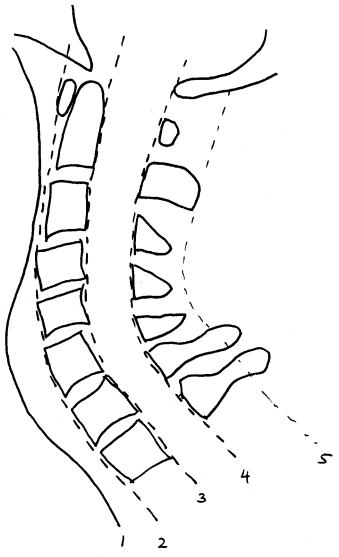
On a supine AP chest Xray a haemothorax may be difficult to detect as there may only be a white haze present on the affected side. When in doubt request a lateral decubitus xray. Similarly a pneumothorax may also be difficult to detect, this is best seen in erect films taken in expiration.

A subpulmonic haemothorax may appear as a raised diaphragm on the affected side, if in doubt request a lateral decubitus CXR.

2) Cervical Spine Xrays

The lateral cervical spine radiograph taken after spinal trauma is the single most useful projection. All seven cervical vertebrae should be included. Special projections such as the swimmer's view should be performed if the C7/T 1 junction cannot be visualized.

The 5 spinal lines to be assessed are as follows :



Line 1 : Pre-vertebral soft tissue line.

Anterior to the upper four cervical vertebrae, the maximum pre-vertebral soft tissue width is 5mm, while in the lower cervical spine

the soft tissue width should not exceed the AP diameter of the adjacent vertebral body.

Line 2 : Anterior spinal line
This line links the anterior cortices of the cervical vertebral bodies, and should form a gently curving line.

Line 3 : Posterior spinal line
This links the posterior cortices of the cervical vertebral bodies, and should form a gently curving line.

Line 4 : Spinolaminar line
The line links the junctions between the laminae and base of the spinous processes of the cervical vertebrae. It should form a gently curving line.

Line 5 : The spinous processes should be examined for the presence of fractures.

3) Pelvic Fractures

These can be broadly classified into stable and unstable fractures.

1. *Stable fractures :*
   a) do not involve the pelvic ring e.g. avulsion fractures, isolated fractures of the iliac wing
   b) involve the ring but result in little bone displacement, leaving the soft tissues intact.

2. *Unstable fractures :*
   Generally involve the pelvic ring in two or more sites. Look carefully at the posterior sacroiliac joints for possible displacement, indicating instability. These fractures are often associated with severe visceral and major vessel damage.

SUMMARY

The ABC system of managing the resuscitation of the severely injured patient during the first few minutes to one hour of arrival offers a safe, efficient initial approach to the trauma patient. The flow of the process identifies the potentially lethal injuries first and takes steps to reverse them as they are discovered. Management of a condition is possible without a firm diagnosis, it may not be known what the cause of the problem is, but there must be clarity about what to do about it.

The first priority is to evaluate the patient rapidly and to detect and treat all immediately life threatening conditions.

Following this, a detailed head to toe assessment can be completed. The team leaders can then list the patient's injuries and establish priorities for both further investigation and definitive treatment.

An adequate history of the patient and the incident is as essential as the clinical examination in evaluating and managing the trauma patient.

1.6.3 Assessment and Management of the Seriously Ill Adult Patient (e.g. Acute Asthma, Pneumonia, Status Epilepticus etc)

Severe trauma (ATLS) and cardiac patients (ACLS) make up only a part of the total number of patients seen in the emergency setting. To deal with a broad range of medical emergencies eg, acute asthma, severe pneumonia, pulmonary embolism, pulmonary oedema, exacerbation of COPD, poisoning, status epilepticus etc, we will now outline an approach to the management of patients presenting with these problems. There is obviously a certain amount of overlap with the ACLS and ATLS approaches, but it is however useful to present an approach to these conditions separately as they constitute a large proportion of emergencies seen.

1.6.3.1 INITIAL STABILISATION

- ASSESSMENT OF VITAL FUNCTIONS AND IMMEDIATE TREATMENT OF IDENTIFIED LIFE THREATENING ABNORMALITIES

1. POSITION PATIENT APPROPRIATELY

a) The unconscious patient

To avoid obstruction of the airway, position the patient head down and in the left lateral position, with neck flexed and head extended (if trauma and cervical spine injury is suspected, do not move the neck). This prevents the tongue from falling back over the airway. Also, if the patient vomits, it is more likely to run out of the mouth rather than down the airway.

b) The dyspnoeic patient

The patient who is dyspnoeic will often prefer to sit upright. There are good physiological reasons for this. It enables optimal use of accessory muscles of respiration and in the case of pulmonary oedema, helps reduce shunting. Managing these patients in the upright position will not only reduce hypoxia, but also get maximal co-operation.

c) The child with partial upper airway obstruction

Unless the child is in extremis, the best place is sitting up in the parent's lap. The sitting position allows the child to hold the head and neck in a way that maintains patency of the airway. Being seated on the lap has a calming effect on children in an environment, which is quite frightening to them. This may decrease the risk of converting a partial airway obstruction into a complete one.

d) The shocked patient

The supine position is best for patients in shock. It allows for the most efficient use of the cardiovascular compensatory mechanism and hence, the best perfusion of the vital organs. The use of Trendelenburg (feet elevated above the head) is controversial and has not been shown to make any difference to patient outcome or improve physiological parameters.

e) The head injured patient

Unless shock or spinal injury is present, patients should be positioned with head elevated at 30 degrees to the horizontal. This may reduce intracranial pressure.

f) The patient with facial trauma or partial upper airway obstruction from any cause

If the patient is conscious and does not have a significant cervical spine injury, encourage self posturing to maintain airway patency. In the setting of facial

trauma this helps to prevent any facial fractures from falling backwards and occluding the airway, and will also stop blood from running down the airway.

g) The pregnant patient

In the third trimester of pregnancy care has to be taken if the patient is lying flat to prevent supine hypotension from vena caval compression. This will require a wedge under the right flank or positioning of the patient in the left lateral position.

2. AIRWAY

Keep patent. This may require a combination of standard airway opening manoeuvres or more complex manoeuvres. Protect cervical spine with a hard collar or in line immobilisation if there is a suspicion of trauma.

3. BREATHING

Measure the respiratory rate. If inadequate, assist ventilation with a bag valve bag (Ambu Bag) attached to oxygen.

Measure SaO2. If < 95% and not requiring assisted ventilation, administer oxygen via an appropriate face mask at a rate according to the clinical circumstance.

4. CIRCULATION

- If in cardiac arrest, commence CPR, otherwise:
- Measure pulse rate, blood pressure and capillary refill
- Attach to a cardiac monitor and assess the rhythm. Correct any life threatening rhythm disturbances.
- Insert an IV cannula
- Take blood from the cannula for appropriate blood tests
- If in shock, give fluids and inotropes as appropriate

5. DISABILITY

Record a Glasgow Coma Scale (GCS) and pupil response. If GCS 8 or less, consider intubation to protect the airway.

6. MEASURE

Temperature and finger prick sugar

7. MONITOR

ECG, SaO2, Blood pressure

1.6.3.2 DIRECTED HISTORY AND EXAMINATION

In the setting of the emergency management of a seriously ill patient, traditional history taking must be modified so as to be directed and focussed on he patient's immediate illness. For example, an extensive systems review and family history are not initially necessary when managing a patient with acute asthma.

Similarly, a full neurological examination is not appropriate on a patient who has epiglottitis. In the seriously ill patient, a history and examination, which are **directed** save time and will prevent a loss of focus on the patient's most immediate needs.

1. **HISTORY**

   Ask about :

   - EVENT - duration and onset of symptoms
   - SYMPTOMS - pain, dyspnoea, cough etc
   - PAST HISTORY

2. **EXAMINATION**

   A focussed clinical examination is performed.

3. **SPECIAL INVESTIGATIONS**

4. **MONITORING**

   ECG, pulse, blood pressure etc

1.6.3.3 COMMENCE SPECIFIC TREATMENT

After the stages of initial stabilisation and directed history and examination, most seriously ill patients will require a small number of **pivotal interventions or treatments,** which are often **time critical.** For example, the giving of antibiotics to a patient with sepsis or the commencement of rehydration and insulin in diabetic patients.

1.6.3.4 DISPOSITION

This can be a deceptively difficult and time consuming stage of the emergency management of the seriously ill patient. However, the essential components of this stage are good communication with staff who will be responsible for the ongoing management of the patient, and vigilence concerning repeated assessment of the patient.

1.6.4 Assessment and Management of the Critcally Ill and Injured Infant and Child (APLS, PALS)

Cardiopulmonary arrest in infants and children is rarely a sudden event. Instead, it is often the result of progressive deterioration in respiratory and circulatory function. The epidemiology of cardiopulmonary arrest is different from that of adults. Sudden primary cardiac arrest in infants and children is uncommon. More commonly, injury or disease causes **respiratory or circulatory failure,** which progresses to **cardiopulmonary failure** with hypoxaemia and acidosis culminating in **cardiopulmonary arrest.**

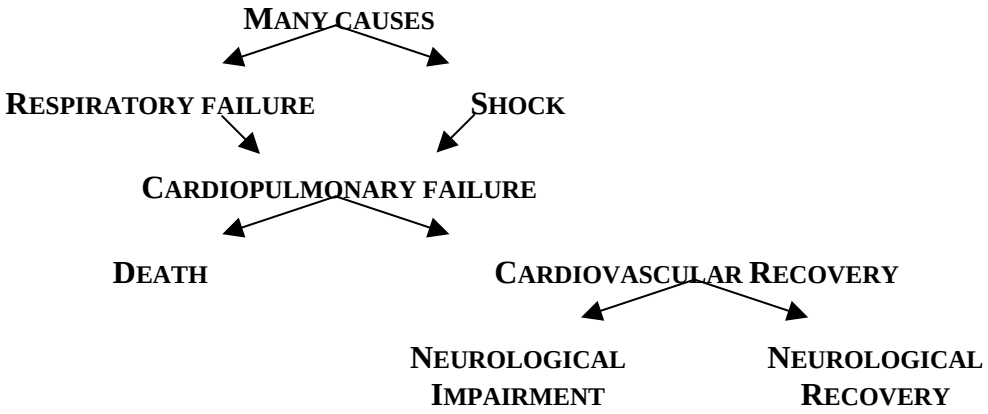
Intact survival from normothermic **asystolic or pulseless cardiac arrest** is uncommon.

In contrast, **respiratory arrest** alone is associated with a survival exceeding 50% when prompt resuscitation is provided.

Paediatric cardiopulmonary arrest occurs most commonly at either end of the age spectrum - in children younger than one year and in adolescence.

When cardiopulmonary failure is detected, initial priority is given to ventilation and oxygenation. If circulation and perfusion fail to improve rapidly, therapy for shock is provided.

Below is the path of various disease states leading to cardiopulmonary failure in infants and children (APLS).

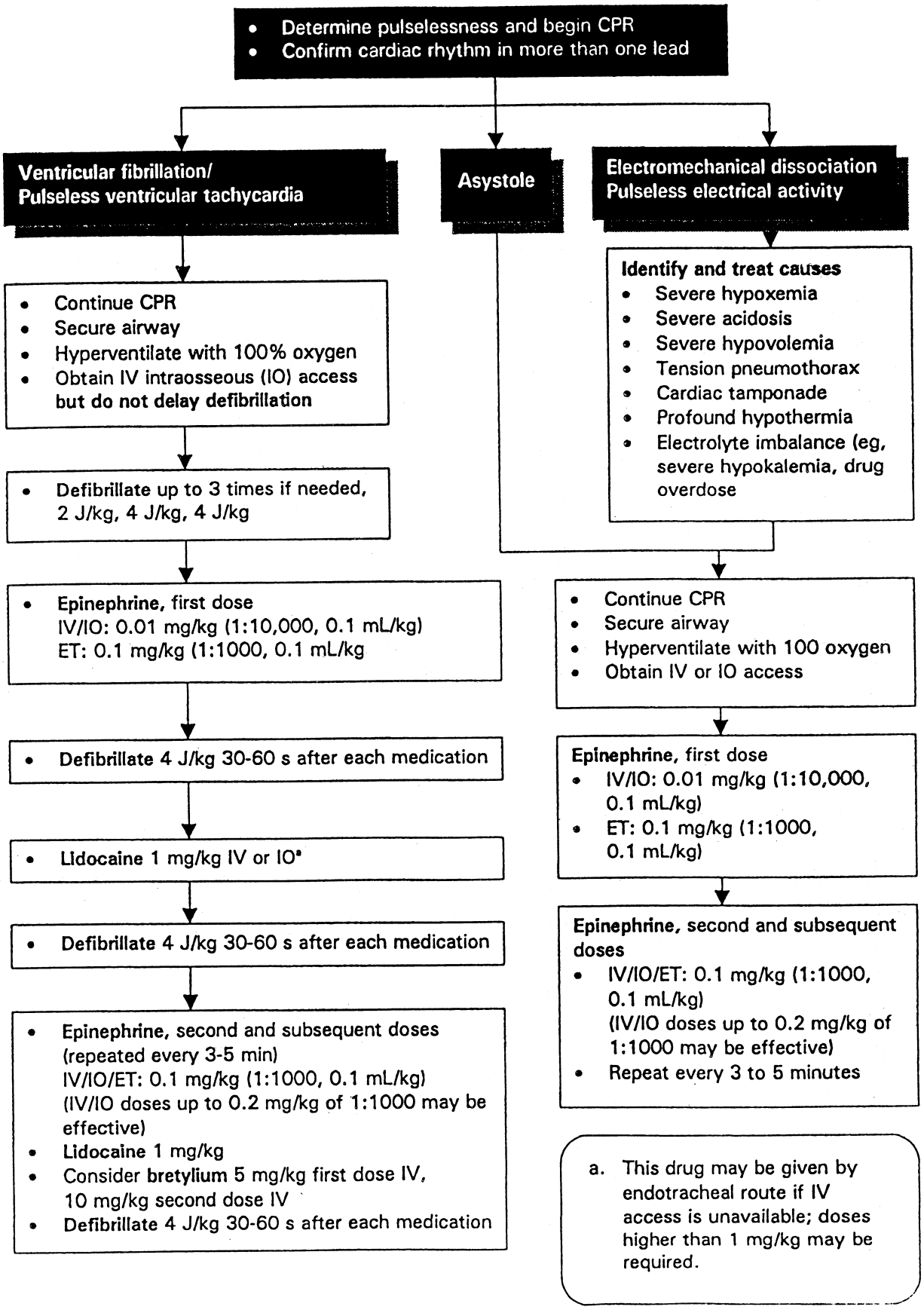


Summary of BLS Manoeuvres in Infants and Children

MANOEUVRE	INFANT (<1 YEAR)	CHILD (1 TO 8Y)
AIRWAY	Head tilt/chin lift(if trauma present, use jaw thrust)	Head tilt/chin lift(if trauma present, use jaw thrust)
BREATHING		
Initial	Two breaths at 1-2secs/breath	Two breaths at 1-2secs/breath
Subsequent	20 breaths/min (approximate)	20 breaths/min (approximate)
CIRCULATION		
Pulse check	Brachial/femoral	Carotid
Compression area	Lower half of sternum	Lower half of sternum
Compression with	2 or 3 fingers	Heel of one hand
Depth	Approximately one third to one half the depth of the chest	Approximately one third to one half of the depth of the chest
Rate	At least 100/min	100/min
Compression-ventilation ratio	5:1 (pause for ventilation)	5:1 (pause for ventilation)
Foreign body airway obstruction	Back blows/chest thrusts	Heimlich manoeuvre

(APLS)

Asystole and Pulseless Arrest Decision Tree



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1.6.5 Resuscitation of the Newborn

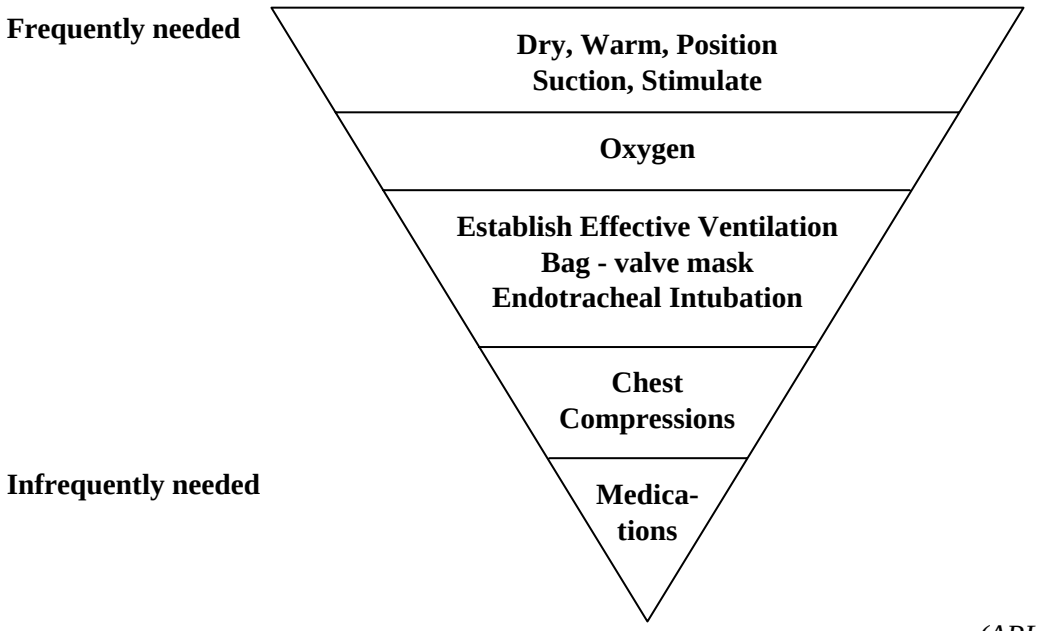
Marked changes in the cardiovascular and respiratory systems occur at birth. The cardiovascular system undergoes a transition from foetal to neonatal circulation. The respiratory system, essentially nonfunctioning in utero, must suddenly initiate and maintain oxygenation and ventilation. The aim of resuscitation is to restore and support cardiopulmonary function.

The vast majority of neonates require no resuscitation beyond maintenance of temperature, suctioning of airway and mild stimulation. Only a small number of neonates require further intervention, and most of these respond to administration of a high concentration of inspired oxygen and ventilation with bag and mask. A few newborns who are severely asphyxiated may require chest compressions, and even fewer need resuscitative medications.

PRESENTED BELOW:

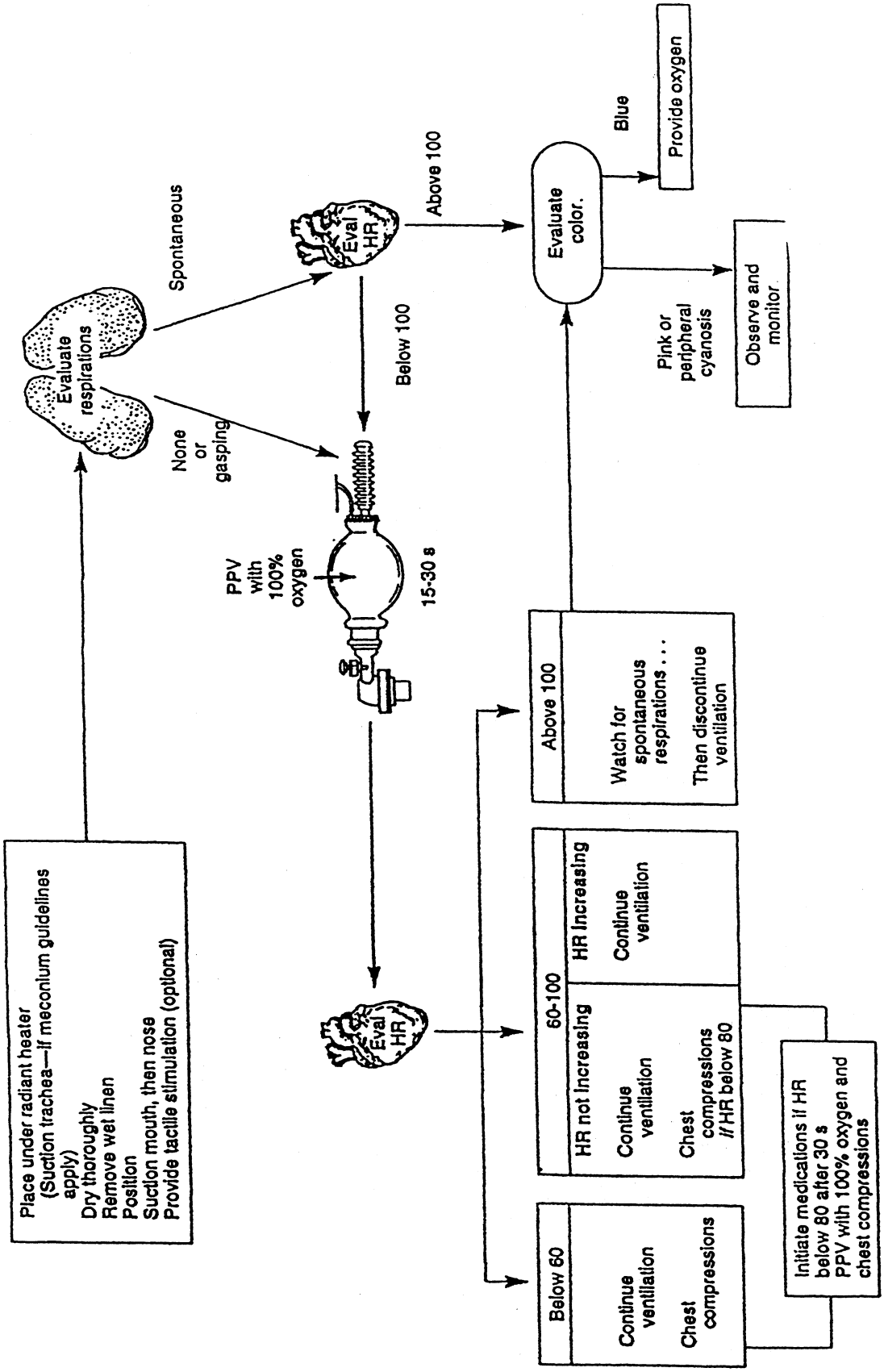
An inverted pyramid reflecting relative frequencies of neonatal resuscitation efforts for the the newborn who does not have meconium stained amniotic fluid. Note that a majority of newborns respond to simple measures.

Assess and support : Temperature (warm and dry)
Airway (position and suction)
Breathing (stimulate to cry)
Circulation (heart rate and colour)



(APLS)

SCHEMATIC REPRESENTATION OF RESUSCITATION OF THE NEWBORN



Chapter 2
AIRWAY

INSTRUCTIONAL OBJECTIVES

By the end of this module you should be able to :

- demonstrate competence in the diagnosis and management of airway emergencies including :
  - airway opening techniques
  - inhaled foreign bodies
  - epiglottitis
  - croup
  - burns
- be familiar with the special considerations for facial and airway trauma
- perform the following basic procedures:
  - head tilt
  - chin lift
  - jaw thrust
  - oropharyngeal airway
  - nasopharyngeal airway
  - airway suction
  - use of nebulised adrenaline
- perform the following post basic skills :
  - endotracheal intubation, both basic and difficult intubation
  - needle cricothyroidotomy and jet insuflation
  - formal cricothyroidotomy

2.1 INTRODUCTION TO AIRWAY ASSESSMENT AND MANAGEMENT

Airway is of paramount importance in any clinical setting. It must always be **assessed first,** and if any compromise or potential compromise is found, this must be dealt with as a first priority.

AN AIRWAY MUST BE :

1. **Patent**

   Having a patent airway is an **absolute** first priority for any patient. An obstructed airway can be **actual** (i.e. partially or completely obstructed) or **potential** (eg airway burns which may result in progressive obstruction over the following few hours).

2. **Protected**

   This is a **relative** priority. It does **not** take priority over the initial assessment and management of a patient's breathing and circulation.

An airway is unprotected when the normal protective reflexes are absent. This is most commonly associated with a decreased consciousness level. A GCS of 8 or less is usually associated with an unprotected airway.

Cervical spine protection is part of airway assessment and management. Any patient with a decreased level of consciousness, who has had trauma to the head or neck, or complains of neck pain, should be treated as having a potential cervical spine injury until proved otherwise. In line immobilization of the cervical spine or protection by a hard cervical collar must be provided while manipulating the airway.

2.2 ASSESSMENT OF AIRWAY

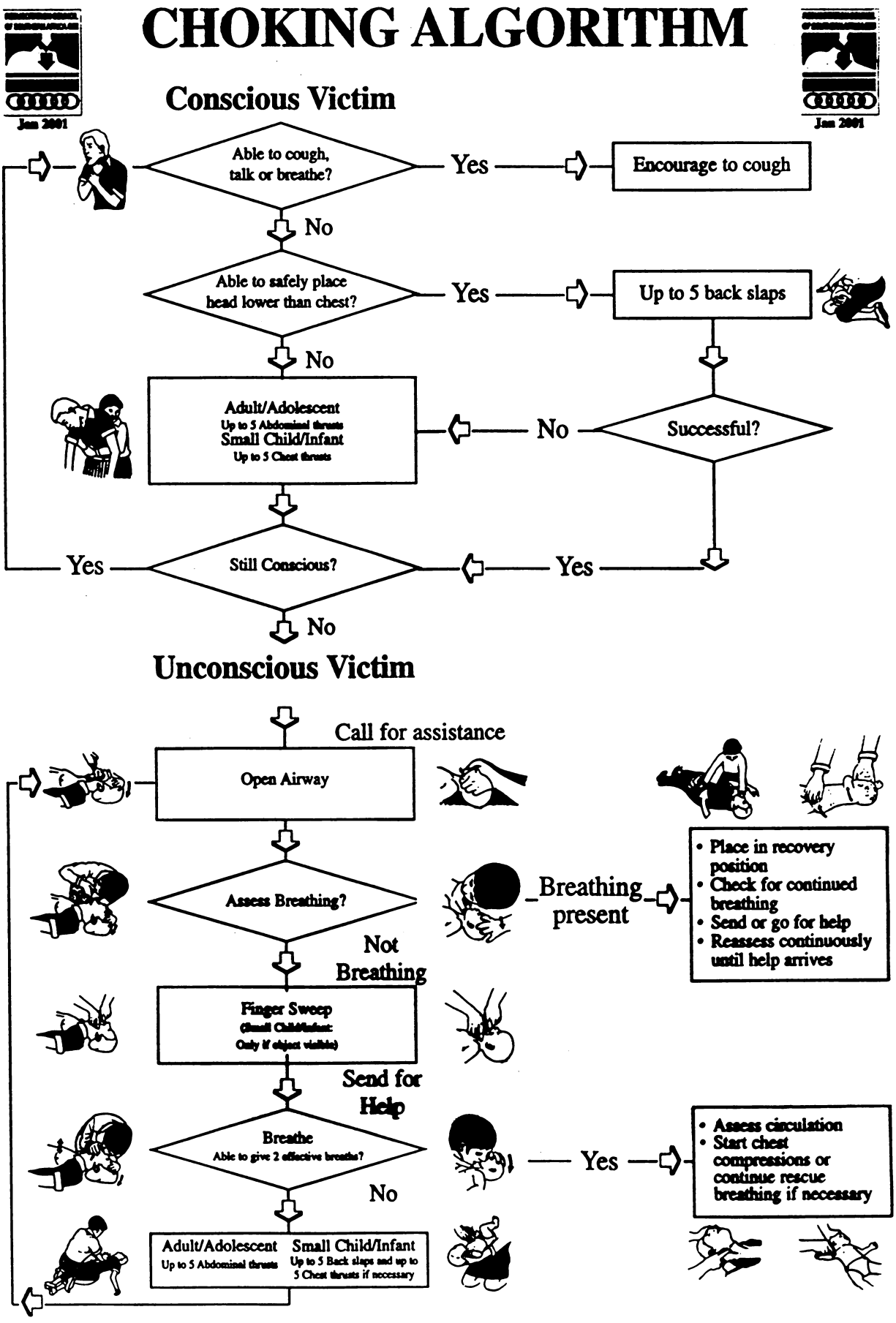
Assessment usually involves **examination before history** as the majority of cases of airway compromise, either actual or potential, are evident by simple observation.

1. **EXAMINATION - LOOKING FOR :**
   - **Signs of complete obstruction**
     - **no** air movement present
     - grabbing at throat
     - paradoxical breathing with extreme respiratory distress ie abdomen moves inwards while chest expands during attempted inspiration
     - cyanosis
     - agitation
   - **Signs of partial obstruction**
     - still **some** air movement present
     - **stridor**, cough , self posturing if patient is conscious (eg sitting up and leaning forwards)
     - use of accessory muscles of respiration
     - **cyanosis** while breathing room air is a **late** sign of partial upper airway obstruction
   - **Signs of potential obstruction**
     - **normal** air movement
     - none of the above features
     - swollen face, swollen tongue, sore throat, external neck trauma, circumferential neck burns, sooty sputum, burnt mouth/tongue/nasal hairs, history of fire or explosion in an enclosed space
   - **Signs suggestive of difficult intubation**
   - **Signs of a non protected airway**
     - GCS 8 or less
     - Absent gag/cough reflex

2. **HISTORY - ASK ABOUT**
   - **symptoms of partial airway obstruction**
     - voice changes, cough, sore throat
   - **Features which suggest potential airway obstruction**
     - burns in an enclosed space
     - history of difficult intubation

2.3 MANAGEMENT OF AIRWAY

CHOKING ALGORITHM (Resuscitation Council of South Africa)



1. SIMPLE MEASURES

- **Position the patient** eg the recovery position (left side, head down) for the unconscious patient. This will keep both the airway patent and provide a degree of protection.
- **Suction** the airway to clear secretions, blood or other fluids
- **Heimlich manoeuvre** - where appropriate

2. SIMPLE AIRWAY OPENING MANOEUVRES - PERFORMED WITH THE PATIENT SUPINE

- **Head tilt :** This maneouvre is performed behind or beside the patient's head. Placing the head in the sniffing position ie with the neck **flexed** and the head **extended.** This is contraindicated in cases of potential or actual cervical spine injury. Great care must be taken in small children to avoid hyperextension of the head as this itself may occlude the airway.
- **Chin lift :** This is performed from behind or beside the patient's head. Grip the chin from behind by placing your thumb below the lower lip, slightly retracting it, and your fingers on the underside of the chin. With this 'pistol grip' pull the mandible forwards and upwards. This lifts the tongue away from the posterior wall of the pharynx.
- **Jaw thrust :** This is performed from a position behind the patient's head. Place your hands on either side of the head with the little fingers behind the angles of the mandible. Then lift the mandible forward, which lifts the tongue away from the posterior wall of the pharynx. This is the method of choice in patients with cervical spine injury.

None of these simple airway opening techniques will provide airway protection.

3. SIMPLE ARTIFICIAL AIRWAY OPENERS

- **Oropharyngeal airway**

  This is easy to insert. The correct size is that where the length from the flange to posterior tip reaches from the incisors to the angle of the mandible. An average adult will take a size 3. In adults it is inserted into the mouth upside down and then rotated through 180 degrees on reaching the oropharynx. In children it is inserted in the position of function (a tongue depressor may be used to hold the tongue clear) as the rotation may injure the soft palate.

  Advantages

  - cheap
  - easy
  - effective
  - safe

  Disadvantages

  - does not protect the airway
  - if the patient is conscious there may be gagging, coughing, straining and vomiting.

  Complications

  - failed placement causing airway obstruction
  - trauma
  - vomiting and aspiration

- **Nasopharyngeal airway**

  This is a softer artificial airway than the oropharyngeal and it is passed along the floor of the nose into the pharynx. The correct size is that with a length from flange to tip adequate to reach from the nares to the angle of the mandible. It must be lubricated prior to insertion.

  Advantages

  - can be used in patient with clenched jaw
  - does not cause as much gagging as an oropharyngeal airway
  - does not have to negotiate the tongue

  Disadvantages

  - more difficult to insert
  - cannot use if possible fracture to base of skull, facial fractures
  - does not protect the airway
  - haemorrhage more likely

  Complications

  - as for oropharyngeal airway with the addition of intracranial placement in the setting of fractured base of skull.

4. COMPLEX OR DEFINITIVE AIRWAY TECHNIQUES

- **Endotracheal intubation**
- **Laryngeal mask airway**
- **Surgical airways**

These are only for use by those skilled to do so. The timing of these interventions depends on whether the airway compromise (to patency and protection) is actual or potential. If it is actual and more simple manoeuvres have not been effective, then the need for the procedure is immediate and urgent. If the airway compromise is potential, then the procedure can be delayed until:

- All appropriate staff and equipment are assembled
- The patient is fully assessed with regard to breathing and circulation and treatment of these is at least commenced, if not completed eg pneumothoraces managed or excluded.
- Neurological status has been assessed.

2.4 AIRWAY SUCTION

OBJECTIVES

To become familiar with the appropriate equipment and technique for the suctioning of the airway.

THEORY

Obstruction of the airway may occur due to pooling of secretions, blood, vomit or other debris in the airway. Suctioning of the airway should be done with an appropriate size sucker and in conjunction with airway opening manoeuvres.

TECHNIQUE

1. Ensure that suction tubing is attached to the suction outlet, via a suction bottle for collection of secretions / vomitus.
2. Tubing should be large bore to facilitate passage of blood or vomitus.
3. The sucker should be a rigid, surgical sucker with a rigid tip and large bore openings.
4. In conjunction with basic airway opening techniques the sucker should be gently inserted into the pharynx and mouth, and secretions removed. It may be necessary to clear the tip to remove large particulate matter.
5. The placing of an oropharyngeal airway will prevent the patient from biting down on the sucker.
6. In patients with clenched teeth, the airway can be suctioned with the aid of a **flexible** sucker passed down a **nasopharyngeal** airway.

2.5 ROUTINE INTUBATION

OBJECTIVES

- To know the indications for endotracheal intubation
- To be able prepare for and perform safe endotracheal intubation
- To be able to identify the patient who is likely to be a "difficult intubation"
- To be able to prepare a Difficult Intubation Tray
- To have a methodical approach to the management of a "difficult intubation"
- To know and be able to perform the range of available options in the management of the "difficult intubation"
  - The "BURP" technique (see later)
  - The laryngeal mask
  - Airway Bougie insertion
  - Needle Cricothyroidotomy
  - Cricothyroidotomy - open technique
    - Seldinger technique
- To know the advantages, disadvantages, and complications of each of the above techniques.

INDICATIONS FOR INTUBATION

- To maintain airway patency
- To maintain airway protection (GCS 8 or less)
- Hypoxia / hypercarbia (respiratory failure)
- Provision of therapy eg hyperventilation in head injury (controversial)
- Investigation eg CT scan without motion artefact

PREPARATION FOR ENDOTRACHEAL INTUBATION

1. The Staff

- Assemble the most experienced staff available
- The ideal number of staff required is 3
  - the person intubating
  - the person assigned to administer the medications and deliver the requested equipment
  - the person assigned to provide **cricoid** pressure (or **thyroid** "BURP" pressure if difficult intubation is anticipated)
- **A fourth staff member** will be needed to perform in line stabilization of the cervical spine if there is a possibility of injury.
- **Allocate** and **demonstrate** how to perform these specific tasks **before commencing** the procedure so that all are clear as to their role.

2. The equipment

- Have a regular protocol established whereby all equipment required for the procedure is **checked** at the start of each shift as being present and functional.
- Where time permits, **recheck** all equipment before commencing.
- Ensure :
  - laryngoscope is present and working. Have a size 3 and size 4 laryngoscope blade available for adults.
  - an appropriate sized oropharyngeal airway is available
  - the bag valve mask is functional and is attached to oxygen and has an appropriate sized face mask fitted
  - the appropriate sized endotracheal tube is present and, if it is cuffed, that the cuff does not leak. Tube sizes are usually :

    adult male size 8-9mm
    adult female size 7-7.5mm
    child 4mm + age/4 (uncuffed up to age of 8 years)
  - a lubricated introducer is placed inside the endotracheal tube
  - the Yankeur suction is working
  - all medications are ready and available in appropriate doses
  - have the "crash trolley" and Difficult Intubation Tray ready

3. The Patient

- Secure IV access and flush cannula to ensure patency
- Where feasible ensure the patient is fasted 4-6 hours (this is not usually possible in the emergency setting)
- If the need for intubation is not immediate, treat or exclude comorbid conditions which may be exacerbated by intubation eg pneumothorax, hypovolaemia
- **Position** the patient supine with the head extended and the neck flexed. This may be facilitated by a thin pillow being placed under the head. This

position will not only maintain an open airway to aid bag valve ventilation, but will also aid intubation.

- **Cervical spine precautions** should be observed where there is a likelihood of cervical spine injury. (use in line stabilization ie a person is allocated to squat beside the intubator and hold the patient's head at the sides **without** applying traction and preventing movement as much as possible during intubation)
- **Preoxygenate** with 100% oxygen for 5 minutes. This is usually achieved using a bag valve mask attached to oxygen. If the patient is breathing spontaneously manual ventilation is not necessary and may risk gastric distension and regugitation/aspiration.
- **Monitor :** SaO2, ECG, BP

ENDOTRACHEAL INTUBATION

(Rapid Sequence Induction)

- Preparation as above
- Administer the sedation of choice eg
  - thiopentone 1mg/kg and titrate up to 4mg/kg as necessary

    OR
  - midazolam 0.1-0.3mg/kg
- **Apply cricoid pressure**
- Administer neuromuscular blocker (only after patient sedated) eg suxamethonium 1-1.5mg/kg
- Holding the laryngoscope in the left hand insert the blade into the patient's mouth, down the right side of the tongue and pushing the tongue to the left. Insert down as far as the vallecula. Then pull forward (**don't lever on the top teeth)**
- Identify the vocal cords and under direct vision , pass the endotracheal tube between the cords and on into the trachea for 3-4 cm. The tube should measure 21cm at the lips in females and 23cm in males. Remove the introducer.
- Inflate the cuff until there is no air leak around it when ventilating.

- Attach the tube to a bag valve mask attached to oxygen, manually ventilate and **confirm tube placement** in trachea by assessing :
  - air entry in axillae
  - SaO2
  - ETCO2 (if available), this should read about 40mmHg
  - patient colour
  - ECG
  - BP
- If any problems, extubate, reventilate, and reoxygenate with bag valve mask attached to oxygen and re-intubate.
- Release the cricoid pressure only when the tube placement is confirmed.
- Anchor the endotracheal tube firmly with linen tape
- Insert a nasogastric tube
- Arrange a chest Xray to check for endotracheal and nasogastric tube position and for any complications of the procedure eg pneumothorax.

COMPLICATIONS OF INTUBATION

1. During the procedure

- Failed intubation with loss of airway and hypoxia
- Regurgitation / vomiting and aspiration
- Oesophageal intubation causing gastric distension or oesophageal trauma
- Right main bronchus intubation with atelectasis of left lung and hypoxia
- Trauma
  - airway trauma eg dental injury, haemorrhage, vocal cord injury
  - pneumothorax
  - pneumomediastinum
  - cervical injury or exacerbation thereof
  - dislocation of mandible
- Complications of the drugs administered :
  - Thiopentone - hypotension
    - histamine release
  - Suxamethonium - raised intracranial, intragastric and intraocular pressure
    - histamine release
    - hyperkalaemia in patients with burns, spinal injuries
    - bradycardia in infants

2. While tube is in place

- Tube obstruction/kinking
- Tube displacement either into oesophagus or into right main bronchus
- Barotrauma with pneumothorax
- Aspiration

IMPORTANT POINTS

1. Always maintain a well prepared crash trolley.
2. Ensure that before intubation the staff, the equipment and the patient are prepared as much as time allows.
3. Check all equipment before commencing.
4. If hypoxia occurs, assume tube malfunction or malposition first. If in doubt, extubate, ventilate, re-oxygenate and re-intubate with a fresh tube.

2.6 THE DIFFICULT INTUBATION

DEFINITION

Attempted endotracheal intubation under direct vision with standard equipment that is not achieved after two attempts.

CAUSES

- **Inadequate preparation / technique - most common cause of a difficult endotracheal intubation**
- **Anatomical**
  - Neck : short "bull" neck
    congenital abnormalities
  - Mandible : small, large
  - Teeth : abnormal dentition, especially "buck teeth"
  - Larynx : anterior caudal larynx
  - Other : excessive facial hair
    pregnancy (advanced)
- **Pathological**
  - Trauma - to the face or neck (blunt, penetrating, burns)
  - Connective tissue disease affecting the mobility of the neck or mandible
  - Goitre or other mass in the neck
  - Obesity
  - Airway obstruction (foreign body, epiglottitis)

ASSESSMENT

- History of previous problems with airway procedures, connective tissue disease etc
- Physical assessment
  - ability to visualize the soft palate, and in particular the uvula
  - ability to extend the head
  - recessed chin
  - significant upper airway bleeding
  - airway burns or anatomical disruption due to trauma, mass etc.

PREPARATION AND PREVENTION

Preparation has three components :

1. **The Equipment**

2. **The Patient**
3. **The Staff**

MANAGEMENT

Where difficult intubation is predicted

- Call a doctor experienced in airway management before commencement (if time allows)
- Before commencing, assess whether the patient's airway and breathing can be maintained using the bag valve mask.
- Plan to attempt laryngoscopy under sedation only ie avoid using neuromuscular blockers if possible.
- Have the **difficult airway tray handy**

Where difficult intubation occurs

1. ***Stop-Reoxygenate-Rethink***
   - Remove ETT
   - Attempt to re-ventilate /re-oxygenate with bag valve mask attached to oxygen in combination with simple airway opening manoeuvres eg jaw thrust, nasopharyngeal tube
   - Ask - why did the intubation fail? eg incorrect head position, incorrect sized laryngoscope blade, inadequate preparation?
     - is the intubation urgent?
     - can oxygenation be maintained?
     - what is the risk of aspiration?
2. ***Then If***

   Can't Intubate / Can Ventilate
   - Options :
     - Manipulate the larynx - Backward Upward Right Pressure (see later)
     - Airway bougie (see later)

   Can't intubate / Can't Ventilate
   - Options :
     - Laryngeal Mask - size 2 for children
       - size 4 for adults

       Allows - positive pressure ventilation
     - passage of bougie as above to facilitate intubation
     - passage of a 6mm uncuffed ETT through the lumen and into the trachea (see later)
3. ***If this Fails - Surgical Airway***
   - Transtracheal jet insufflation

     OR
   - Cricothyroidotomy

IMPORTANT POINTS

1. Predetermine lines of referral for senior medical backup if possible.
2. Be prepared with well trained staff and regularly checked equipment, including a Difficult Airway Tray.
3. Assess the patient for evidence of possible difficulties before commencing the procedure (if time permits)
4. If you are not an experienced intubator or difficult intubation is predicted, summon senior help early.
5. Where difficult intubation is predicted, attempt initial laryngoscopy under sedation alone before giving neuromuscular blockers.
6. If difficult intubation is encountered, **Stop, Re-Oxygenate, Re-think.**

2.6.1 Techniques for Management of Diffcult Intubation

2.6.1.1 B.U.R.P.

This applies to a technique to aid visualization of the larynx when the larynx lies caudal and anterior. It refers to the application :

Backward - to push the larynx backwards

Upward - to push the larynx as superiorly as possible

Rightward - no more than 2cm

Pressure - to the thyroid cartilage (NB. n**ot the cricoid**)

2.6.1.2 LARYNGEAL MASK

This airway is the ideal emergency airway for use by unskilled practitioners. It however does not provide airway protection and therefore in emergency situations should only be seen as a temporary measure. In emergency situations it can be used as an airway in its own right or as a track for the introduction of an airway bougie or, in adults, for the insertion of a size 6 endotracheal tube.

TECHNIQUE

- Select the appropriate size laryngeal mask
- Partially inflate the cuff (this will make insertion easier)
- Insert the mask into the pharynx with the distal aperture directed caudally until no resistance to further progression is felt.
- Fully inflate the cuff with air (10ml)
- Attempt ventilation
- If insertion fails ie if the patient cannot be ventilated, deflate the cuff and withdraw the mask. Re-attempt the procedure with the distal aperture initially directed cranially, then, once in the pharynx, rotate through 180 degrees as for an oropharyngeal tube.

If desired, an airway bougie or an endotracheal tube may be passed via the lumen of the laryngeal mask into the trachea. This requires plenty of lubricant and may require a 90 degree rotation of the endotracheal tube to manipulate it past the fenestrations in the aperture of the laryngeal mask.

COMPLICATIONS

- Failed insertion
- Trauma to the pharynx
- Regurgitation and aspiration (the recorded incidence of this is low)

ADVANTAGES

- Simple
- Easy to use
- Rapid
- Almost foolproof
- Provides not only an airway, but also a method of attaining a definitive airway

DISADVANTAGES

Does not afford airway protection and can induce gagging

2.6.1.3 AIRWAY BOUGIE

This is an extension of the concept of the introducer. A long piece of elastic material which is semi-rigid can be directed into the trachea when it is impossible to achieve direct intubation because of an inability to see the cords or because of difficulty in directing the endotracheal tube between the cords.

TECHNIQUE

- Under direct vision using the laryngoscope the bougie is passed between the cords as to where the cords are estimated to be.
- An appropriate sized endotracheal tube is then passed over the bougie and into the trachea using the bougie to guide the tube
- If the tube appears to catch at the cords its advancement may be facilitated by twisting the tube through 180 degrees.
- The bougie is then removed, leaving the tube in place.

COMPLICATIONS

- Failed intubation
- Trauma to the airway
- Oesophageal intubation

ADVANTAGES

- Technically simple
- Avoids surgical procedures

DISADVANTAGES

Can be awkward, particularly if endotracheal tube gets snagged at the cords.

2.6.1.4 NEEDLE CRICOTHYROIDOTOMY / TRANSTRACHEAL JET INSUFFLATION

This is a technique for achieving **oxygenation.** It does not provide adequate **ventilation.** It is the emergency surgical airway of choice in children <12 years old. It can be useful in severe maxillofacial trauma, but can also be used in the setting of an upper airway obstruction from any cause.

TECHNIQUE

- Inform the patient/parents if possible.
- Local anaesthesia using 1% lignocaine with adrenaline. This is infiltrated into the skin overlying the cricothyroid membrane and on to the membrane itself. Aspiration of air will confirm the needle's passage beyond the membrane and into the trachea.
- With a 5 ml syringe attached to the cannula and aspirating as you go, advance the cannula tip through the inferior part of the cricothyroid membrane aiming caudally.
- When air is aspirated freely, advance 1-2 mm further, stop and slide the cannula sheath of the needle while holding the needle still. Remove the needle, leaving the cannula sheath in place.
- Now connect :
  - the 3 way stopcock to the cannula
  - the oxygen tubing to the 3 way stop cock
- Commence the oxygen flow at 15 l/min and use the stop cock to control ventilation ie on to the patient on inspiration / off to the patient for expiration.
- Inspiratory phase 2 seconds, or until the chest rises.
- Expiratory phase 4 seconds.
- If expiration is incomplete, insert another cannula next to the first to act as a vent.
- The procedure will **provide adequate oxygenation for up to 45-60 minutes**.

Alternative :

A 2ml syringe can be connected to the cannula after insertion. The plunger is removed from the syringe and the connector from a size 7 ETT is inserted in its place. A bag and valve attached to oxygen can then be connected and the patient oxygenated.

COMPLICATIONS

- Malposition
  - subcutaneous emphysema
  - haemorrhage
- Injury to nearby structures
  - vocal cords
  - cricoid cartilage
  - trachea
  - carotid arteries
  - vagus / recurrent laryngeal nerves
  - jugular veins
  - oesophagus
- Barotrauma
  - especially in infants or in patients with complete upper airway obsrtuction
- Infection

ADVANTAGES

- Less complications than surgical airways
- Easier than other surgical airways
- Requires minimal surgical skills
- Can be used in young children

DISADVANTAGES

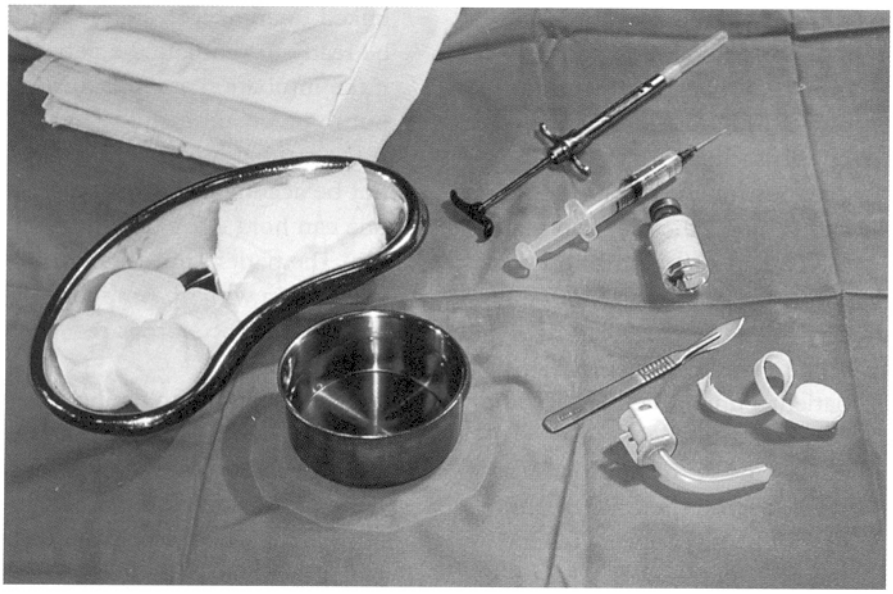
- Does not provide a definitive airway
- Does not provide adequate ventilation
- Exposes the lungs to potentially high pressures

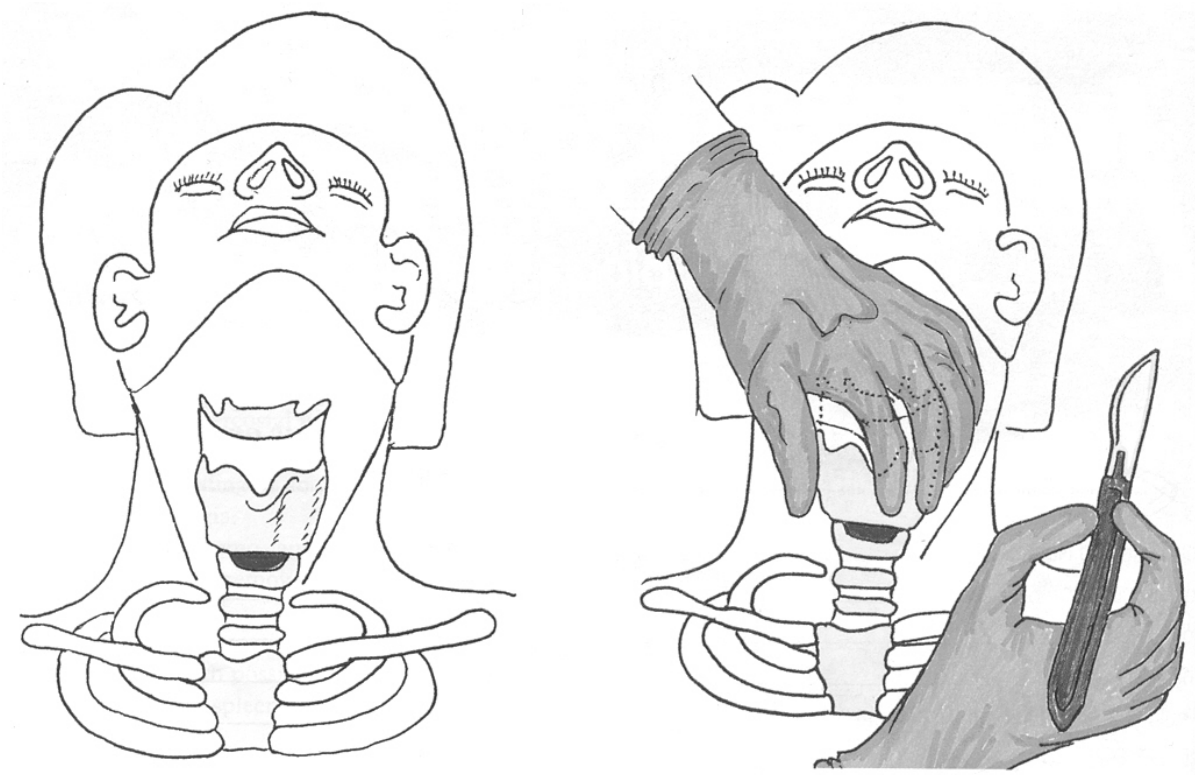
2.6.1.5 FORMAL CRICOTHYROIDOTOMY (SELDINGER TECHNIQUE)

Several commercial sets exist. Many are based on the Seldinger guidewire principle :

- Identfy the cricothyroid membrane by placing the index finger and thumb on the thyroid cartilages and running them caudally until they fall into a groove. The floor of this groove is the crocothyroid membrane.
- Local anaesthesia, using 1% lignocaine with adrenaline, is infiltrated down to the caudal limit of the cricothyroid membrane.
- A needle with syringe attached is inserted in the midline through the caudal edge of the membrane while aspirating. Free aspiration of air indicates penetration into the trachea.
- The syringe is disconnected from the needle and a guidewire passed caudally into the trachea.
- A dilator is then passed over the wire and used to create a passage for the tube.
- The dilator is then removed leaving the wire in situ.
- A trochar with tube is then inserted over the wire and once in place, the wire and trochar are removed leaving the tube in situ.
- The tube is then tied in place.
- Arrange a CXR

2.6.1.6 FORMAL CRICOTHYROIDOTOMY (SURGICAL)





TECHNIQUE

- Identify the cricothyroid membrane as above
- Infiltrate with local anaesthetic using 1% lignocaine with adrenaline
- Using the scalpel make a vertical incision through the skin and down to the membrane
- Make a horizontal incision through the cricothyroid membrane at its junction with the cricoid cartilage
- Use the forceps and scissors to open the aperture and pass the tube into the trachea
- Remove the forceps, inflate the cuff and anchor the tube
- Arrange a CXR

COMPLICATIONS

- Malposition
  - subcutaneous emphysema
  - injury to nearby structures (as above)
- Haemorrhage
- Failure and resultant hypoxia
- Infection

ADVANTAGES

- Provides a definitive and stable airway
- Simpler and safer than a tracheostomy
- Rapid

DISADVANTAGES

- Landmarks are often difficult in the clinical settings in which it is needed
- Needs some surgical skill
- Is not recommended in a child <12 years
- Seldinger sets are expensive

2.7 ACUTE UPPER AIRWAY OBSTRUCTION

DEFINITION

A life threatening condition where there is complete, partial or potential obstruction of the airway at some point between the teeth and the carina. The degree of obstruction and the speed of onset will vary depending on the cause.

CAUSES

1. **The Patient's Tongue -** this occurs in unconscious patients who are unable to maintain airway patency
2. **Foreign Body -** usually occurs in one of three clinical situations
   - Patients with a decreased level of consciousness and a diminished cough reflex who inhale a foreign body
   - Young children inhaling objects/material that they have put into their mouths
   - Older patients with dentures who lack the ability to sense the size of the food bolus they are about to swallow
3. **Upper Airways Swelling -** due to infection /burns / trauma / oedema

CLINICAL FEATURES

Complete Obstruction

- **no** air movement present
- until the patient loses consciousness there will be :
  - grabbing at throat
  - paradoxical breathing with extreme respiratory distress
  - cyanosis
  - agitation

Partial Obstruction

- still **some** air movement present
- **stridor,** cough, self posturing if the patient is conscious (eg sitting up, leaning forwards)
- use of accessory muscles of respiration
- **cyanosis** while breathing room air is a **late** sign of partial upper airway obstruction

Potential Obstruction

- **normal** air movement
- none of the above features
- swollen face, swollen tongue, sore throat, external neck trauma, circumferential neck burns, sooty sputum, burnt mouth / tongue / nasal hairs, history of fire or explosion in an enclosed space.

IMPORTANT POINTS

1. Cyanosis while breathing room air is a late sign of upper airway obstruction
2. Early upper airway swelling can be very subtle and initially have no clinical evidence of obstruction, yet dramatically obstruct later.
3. Skilled assistance is vital and the doctor most experienced in airway management should be summoned immediately.

2.7.1 Management of Upper Airway Obstruction

INITIAL STABILIZATION

1. **Airway**

- have a difficult airway tray at hand

- **Complete Obstruction**
  - In the emergency Department setting manual manoeuvres (eg Heimlich manoeuvre) to relieve obstruction are not indicated as more definitive measures exist.
  - Initially, use basic airway opening measures and attempt ventilation via bag valve mask attached to oxygen
  - Then attempt indirect laryngoscopy and removal of obstructing agent with a Magill's forceps or suction
  - **If unable to remove the obstruction mechanically** eg when due to swelling, **proceed to emergency surgical airway** ie transtracheal jet insufflation or cricothyroidotomy
  - Then proceed as per "Specific Treatment" below.
- **Partial Obstruction**
  - Encourage self posturing eg in epiglottitis the patient will prefer to sit upright and lean forwards
  - **Unless there is an obviously visible foreign body and the patient is cooperative DO NOT perform any airway clearing manoeuvres, such as the Hiemlich manoeuvre.** This may convert a partial obstruction into a complete one.

- **Potential Obstruction**
  - No immediate intervention is required

Then, for partial obstruction or potential obstruction :

2. Breathing

- Measure respiratory rate. If inadequate, assist ventilation with bag valve mask attached to oxygen.
- Measure SaO2. If < 95% and not requiring ventilation, administer high flow oxygen by mask.

3. Circulation

In partial obstruction great care must be taken to avoid agitating the patient and precipitating a complete obstruction eg measuring the BP or inserting a cannula in a child with epiglottis may cause agitation and precipitate a complete airway obstruction.

4. Disability

Record a GCS and pupil response. **Consider intubation (if this has not already occurred), if GCS is 8 or less to protect the airway.**

5. Monitor

ECG, SaO2, BP (if this will not agitate the patient)

6. Summon

- a senior doctor with airway skills.

DIRECTED HISTORY AND EXAMINATION

Ask About :

Event

- precipitating factors, likelihood of foreign body aspiration

Symptoms

- of possible precipitants eg epiglottitis, croup

Past History

- drug allergies
- medications
- medical problems

Look For :

- stridor, cyanosis
- signs suggestive of particular clinical syndromes eg epiglottitis, croup, angio-oedema

Measure :

- reassess SaO2, respiratory rate, level of consciousness

Tests

- in the airway control phase there is **no test** of any use and tests may **delay** definitive management and worsen the condition.

SPECIFIC TREATMENT

If partial obstruction, potential obstruction or complete obstruction with temporary surgical airway in place :

1. Notify anaesthetist /ENT surgeon or local equivalents
2. Notify the operating theatre
3. When all resources are assembled transfer to the operating theatres accompanied by skilled staff, oxygen, suction, bag valve mask system, difficult intubation tray and surgical airway setup.

DISPOSITION

Depends on the cause, but in most cases would require admission to an Intensive Care Unit after definitive treatment in the operating theatre.

Airway must be stabilized before any inter-hospital transfer is attempted.

IMPORTANT POINTS

1. Heimlich manoeuvre is generally not indicated in the Emergency Department setting.

2. If partial airway obstruction is present then intervention in the Emergency Department should be minimal and the patient should be transferred to the operating theatre accompanied by appropriate staff and equipment.

3. Do not attempt to remove penetrating foreign bodies of the neck in the Emergency Department.

2.8 UPPER AIRWAYS BURNS

DEFINITION

Thermal or caustic burns to the pharynx, larynx or trachea.

1. Thermal Burns

- Heated gases
  - pharyngeal, laryngeal, and tracheal burns are usually the worse affected areas
- Direct Flame
  - injuries usually confined to the face and lips

2. Caustic Burns

- acid / alkali
- intentional or accidental

CLINICAL FEATURES

1. **Thermal Burns**
   - The initial physical findings are notoriously unreliable at ruling out burns to the airway.
   - Suggestive findings are :
     - history of burns in an enclosed space
     - sore throat, painful swallowing
     - facial, nasal or oral burns
     - cough, stridor or voice changes
     - carbonaceous sputum or respiratory distress
2. **Caustic Burns**
   - associated with mucosal ulceration and massive oedema
   - drooling
   - cough, stridor
   - ulceration of the mouth, tongue or pharynx (may appear as white plaques)
   - respiratory distress

IMPORTANT POINTS

1. The initial physical findings can be unreliable in ruling out thermal burns to the upper airway.
2. History of the circumstances of the burn is important to assess the possibility of airway burns (eg confined space, explosion, flame, steam)
3. If thermal upper airway burns are present, also consider carbon monoxide, cyanide or hydrogen sulphide poisoning from smoke inhalation.
4. If caustic burns are present, consider other ingestants as well
5. Airway compromise can be delayed but dramatic in onset.

2.8.1 Management of Upper Airways Burns

INITIAL STABILISATION

1. **Airway**
   - **Complete Obstruction**
     - summon help from the doctor most experienced in airway management.
     - Use basic airway opening techniques (eg suction , head position, oropharyngeal airway, nasopharyngeal airway) and attempt ventilation via bag valve mask attached to oxygen
     - Attempt intubation without the use of muscle relaxants initially
     - If unsuccessful, proceed to emergency surgical airway
   - **Partial Obstruction**

     Diagnosis based on the presence of stridor, hoarse voice and/or respiratory distress.
     - Humidified oxygen

- Notify anaesthetist/surgeon
- Transfer to operating theatre accompanied by skilled staff for examination under anaesthetic/intubation or tracheostomy
- **Do not** transfer the patient to another institution until intubated

- **Potential Obstruction**

  Diagnosis based on the presence of sore throat, circumferential neck burns, sooty sputum, burnt mouth/tongue/nasal hairs or history of fire or explosion in confined space. Consider intubation.

2. Breathing

- Measure respiratory rate, and if inadequate, assist ventilation with bag valve mask attached to oxygen.
- Measure SaO2. If <95% and not requiring assisted ventilation, administer high flow oxygen (100% O2 via non rebreather mask if carbon monoxide poisoning is a possibility)

3. Circulation

- Measure pulse rate, BP and capillary refill
- Attach to a cardiac monitor and assess the rhythm
- Insert IV cannula
- Take blood for FBC, biochemistry

4. Disability

Record a GCS and pupil response. Consider intubation (if this has not already been done), if GCS 8 or below, to protect the airway.

5. Monitor

- BP, ECG, SaO2

6. Summon

senior doctor with airway skills

DIRECTED HISTORY AND EXAMINATION

Ask about

Event

- Circumstances of the burn(eg enclosed area, explosion, steam)
- Associated trauma if explosion was involved
- Episodes of loss of consciousness (possibly associated carbon monoxide poisoning or head injury)

Symptoms

- stridor/dyspnoea
- cough
- sore mouth/throat
- hoarse voice

Past History

- associated respiratory illnesses (eg asthma)
- medications
- allergies
- medical problems

Look for

Stridor, voice changes, oral or nasal burns, facial or circumferential neck burns, nature of cough

Tests

Blood gases, Carboxy Hb

DISPOSITION

For complete obstruction with surgical airway in place or partial obstruction:

- Notify anaesthetist, ENT surgeon
- Notify operating theatres
- When all resources are assembled transfer to the operating theatres accompanied by skilled staff, oxygen, Ambu bag, difficult intubation tray and surgical airway equipment

For potential obstruction, admit to an Intensive Care Unit

If patient transfer is to occur, consider intubation prior to transfer

IMPORTANT POINTS

1. Intubate early if signs or history suggesting airway involvement in burns.

2. Be prepared for a difficult intubation.

3. Involve the available doctor most experienced in airway management.

2.9 UPPER AIRWAY TRAUMA

DEFINITION

Blunt or penetrating traumas to the neck or face involving elements of the upper airway.

CAUSES

1. Motor vehicle accidents
2. Assaults
3. Falls
4. Hanging
5. Penetrating injuries

CLINICAL FEATURES

1. **Airway obstruction** is the greatest concern and can be due to :
   - collapse of anatomical structures (eg mid face, mandible, larynx)

- foreign bodies
- haemorrhage
- swelling

Complete Obstruction

- **no** air movement present
- until the patient loses consciousness there will be
  - grabbing at throat
  - paradoxical breathing ie abdomen moves inwards while chest expands during attempted inspiration
  - extensive use of accessory muscles of respiration
  - cyanosis
  - agitation

Partial Obstruction

- still **some** air movement present
- **stridor,** cough, self posturing (eg sitting upright and leaning forward)
- use of accessory muscles of respiration
- **cyanosis** while breathing room air is a **late** sign of partial upper airway obstruction

Potential Obstruction

- **normal** air movement
- none of the above features, **but**
- swollen face, swollen tongue, sore throat, external neck trauma

IMPORTANT POINTS

1. Fractures of the mandible can disrupt the attachments of the tongue to the mandible, preventing effective basic airway manoeuvres.
2. Evidence of airway injury in blunt trauma may be very subtle initially, especially laryngotracheal injuries. Voice changes or dysphagia may be early signs.
3. Cervical spine injuries have a higher incidence in this setting and must be excluded.
4. There is often significant haemorrhage associated with these injuries.

2.9.1 Management of Upper Airway Trauma

INITIAL STABILISATION

1. Position Patient

- allow to self posture when able, to maintain airway patency. Hard collar if cervical spine injury is suspected.

2. Airway

Complete Obstruction

- Summon help from the doctor most experienced in airway management
- Use basic airway opening manoeuvres
- Attempt intubation without use of muscle relaxants initially
- If unsuccessful, proceed to emergency surgical airway

Partial Obstruction

Based on presence of stridor, hoarse voice and or respiratory distress.

- Humidified oxygen
- Notify anaesthetist/surgeon
- Transfer to operating theatre accompanied by skilled staff for examination under anaesthetic/intubation/tracheostomy
- Do not transfer patient to another facility until intubation has occurred

Potential Obstruction

Based on the presence of sore throat, swollen face, swollen tongue, external neck trauma. Consider intubation by a doctor experienced in airway management, especially prior to transfer. Consult with a retrieval service if necessary.

- Mandibular fractures : where the tongue cannot be cleared by special techniques a towel clip or large suture can be used to retract and anchor it.
- Foreign bodies penetrating the face and mouth should not be removed and the wound not explored until the patient is in the operating theatre.
- In laryngeal fracture resulting in airway obstruction, needle crichothyroidotomy is the procedure of choice. Formal cricothyroidotomy should not be performed as this may further disrupt the anatomical structures.
- The trachea can be intubated directly through the neck in a penetrating wound.

3. Breathing

- Measure respiratory rate. If inadequate, assist ventilation with bag valve mask attached to oxygen
- Measure SaO2. If <95% and not requiring assisted ventilation, administer high flow oxygen via mask.
- Examine for associated pneumothorax or other chest injury.

4. Circulation

- Measure PR, BP, and capillary refill
- Attach to cardiac monitor and assess rhythm
- Insert IV cannula
- Take blood for FBC, biochemistry, crossmatch
- If shock is present, give crystalloid rapidly

5. Haemorrhage Control

- Reduce fractures immediately, especially if mid third of face is involved
- Pack nasopharynx if necessary
- Pack or suture other wounds

6. Monitor

- SaO2, BP, ECG

7. Summon

a doctor with airway skills

DIRECTED HISTORY AND EXAMINATION

Ask about :

Event

- mechanism of injury

Symptoms

- voice changes
- painful swallowing
- noisy breathing/dyspnoea

Past History

- medications
- allergies
- medical problems

Look for :

- stridor
- swelling of the neck, palate, tongue
- subcutaneous emphysema in the neck or face
- laryngeal deformity or tenderness
- middle third of face mobility
- significant haemorrhage especially nasopharyngeal

Tests

None pre-stabilisation

Once stable, consider :

- facial Xrays/CT
- CXR
- cervical spine Xray
- CT neck and larynx if possible

SPECIFIC TREATMENT

Laryngeal trauma - where there is no clinical evidence of airway compromise, but there is subcutaneous emphysema due to blunt neck trauma, administer humidified oxygen and commence IV antibiotics for possible salivary contamination of the deep tissues of the neck.

DISPOSITION

For complete obstruction with surgical airway in place, or partial obstruction:

1. Notify anaesthetist/ENT or local equivalents
2. Notify operating theatre
3. When all resources are assembled transfer to operating theatre accompanied by skilled staff, oxygen, suction, bag valve mask system, difficult intubation tray and surgical airway setup.

IMPORTANT POINTS

1. Always maintain a well prepared crash trolley.

2. Ensure that before intubation the staff, equipment and patient are prepared as much as time allows.

3. Check all equipment before commencing.

4. If hypoxia occurs, assume tube malfunction or malposition first. If in doubt, extubate, ventilate, re-oxygenate and re- intubate with a fresh tube.

FURTHER READING

Emergency Medicine, Chris Moulton and David Yates ISBN 0-632 02766-5
Chapter 1 The Principles of Emergency Medicine

Chapter 3
BREATHING

AIM AND OUTCOMES

After studying this section on breathing, you should be able to:

1. Understand and describe the relevant patho-physiology of breathing disorders
2. Describe the broad spectrum of medical and traumatic respiratory disorders
3. Identify, assess and manage disorders of breathing
4. Demonstrate competency in emergency skills and procedures

3.1 INTRODUCTION

A broad spectrum of medical and traumatic **breathing disorders** present themselves to the emergency department. As for any other patient presentation, focus your attention on the presenting complaint, and do a directed history and clinical examination. However, because disorders of many systems can lead to respiratory symptoms, it is important not to be too narrow in your approach. Good examples include severe anaemia presenting as fatigue and shortness of breath, or heart failure presenting as wheezing.

We are going to concentrate on the identification and management of **injuries** compromising the airway and breathing - for practical and self explanatory reasons airway and breathing can be considered together, rather than as separate entities. We are however going to concentrate on chest injuries in this section.

Many **medical** disorders such as asthma, chronic obstructive airways disease (COPD), pulmonary embolism, pulmonary oedema, and lower respiratory infections such as acute bronchitis and pneumonia also present to the emergency doctor. These are not going to be presented in this module, but it is necessary for you to do further reading on these conditions, and be able to competently assess and manage these medical conditions.

3.2 ASSESSMENT

This requires assessment of

- the presence of respiratory effort
- the pattern of respiration (e.g. paradoxical movement, flail chest)
- the adequacy of the respiratory effort :
  - respiratory rate
  - signs of hypoxia e.g cyanosis, mental clouding
  - signs of hypercarbia e.g warm dilated peripheries, sweating, mental clouding
- auscultatory findings of the chest
- the pulse oximetry reading

These clinical signs must be taken in the context of the clinical picture. The signs can be non-specific and **must be interpreted as a package,** rather than individually.

3.2.1 Some important considerations:

3.2.1.1 RESPIRATORY RATE

There is considerable **variation** of this parameter e.g. the "normal" respiratory rate for a neonate is significantly different to that of a 60-year old adult.

3.2.1.2 CYANOSIS

This is an unreliable sign of **hypoxia** and varies with:

- skin pigmentation
- level of haemoglobin
- ambient light
- skin perfusion

3.2.1.3 OXYGEN SATURATION

This is assessed by **pulse oximetry** and has become an integral part of the assessment of respiratory status and indeed is considered an additional vital sign. Like the other vital signs it must be assessed in context and its limitations understood.

The pulse oximeter will display:

- oxygen saturation
- pulse rate
- pulse volume

The last parameter is displayed as a plethysmographic waveform and is subject to more error than the oxygen saturation reading. Alarms are usually present for low saturations and for pulse rates at upper and lower limits. The accuracy for oxygen saturation is +/- 2% only between 70-90% range.

It must be remembered that saturation is not the same as the partial pressure of oxygen and there is not a linear relationship between the two. The relationship is described by the haemoglobin-oxygen dissociation curve and this in turn is not a constant as it is affected by temperature, pH and PCO2.

Rough correlations would be :

75% sat = PaO2 40 mm.Hg

90% sat = PaO2 60 mm.Hg

Factors influencing pulse oximetry readings :

- Signal interference - shivering, movement, high intensity light from another source
- Decreased light transmission - dirty skin, dark nail polish
- Decreased signal volume - poor peripheral perfusion
- Abnormal haemoglobin - carboxyhaemoglobin (causes an overestimation of saturation)
    - Anaemia (especially at levels < 5g% also affect the signal)
- Others e.g. intravenous dyes

3.3 MANAGEMENT OF BREATHING

3.3.1 Assistance of ventilation

- Use of pocket masks for expired air respiration
- Use of bag valve masks (Ambu Bags)
- Oxygen administration

3.3.1.1 USE OF POCKET MASKS FOR EXPIRED AIR RESPIRATION

- Objectives
- Theory
- Technique

OBJECTIVES

To be adept at the use of pocket masks for expired air ventilation of the apnoeic patient.

THEORY

Pocket masks provide a safe way to deliver expired air respiration to the apnoeic patient, without exposing the operator to the potential risks of infectious disease transmission via the patient's secretions. When these masks are available they should be used in preference to mouth to mouth ventilation.

Expired air provides a FiO2 of approximately 16%. Many pocket masks have an oxygen inlet that allows connection via tubing to an oxygen supply if available, thus increasing the FiO2. Patients can be adequately ventilated using this technique until more definitive assisted ventilation methods are obtained.

TECHNIQUE

a) Ensure cervical spine control if this is at risk. Open the airway using simple airway opening manoeuvres. Suction the airway if necessary.

b) Standing behind the patient, place the face mask over the patient's nose and mouth, ensuring that the mask is sealed across the bridge of the nose and below the lower lip above the chin. Hold the mask in place with the thumb and index fingers of each hand on the mask and the rest of the fingers along the mandible, supporting the jaw upwards and forwards.

c) Place a mouthpiece with a **one way valve** on the mask.

d) Breath into the mask via the mouthpiece and check that the patient's chest is rising with the expired air ventilation - if it isn't, check that the airway is not occluded and that the mask has an adequate seal.

NB If a patient has dentures, leave them in place if they are not loose. They will give form to the patient's face and make it much easier to obtain a seal with the mask

3.3.1.2 USE OF BAG VALVE MASKS (AMBU BAGS)

OBJECTIVES

a) To demonstrate an understanding of the indications for the use of bag valve mask ventilation.

b) To demonstrate the correct use of a bag valve mask apparatus.

THEORY

The indications for the use of a bag valve mask are when the patient's breathing rate or effort is inadequate and requires assistance.

The basic bag valve mask system usually consists of:

- A clear face mask which fits over the patient's nose and mouth
- A self filling bag with inlet for oxygen and attached reservoir oxygen bag
- A valve connection between the bag and the mask, which allows one way movement of oxygen from the bag to the patient via the mask, and a separate valve, which allows venting of exhaled gases to the atmosphere.

Often a "pop off" valve is part of the connection between the bag and the mask, which is pre-set to open at a certain pressure. This is to try and avoid barotrauma to the patient's lungs - it is best however to avoid over-inflation of the patient's lungs and not to rely on this safe guard valve. A tidal volume of 7-10 ml/kg, or enough to make the patient's chest rise, is adequate.

TECHNIQUE

- Ensure cervical spine protection if needed, using a hard collar or in line immobilisation.
- Use basic airway manoeuvres to open the airway. Suction the airway if necessary.
- Ensure the equipment is properly assembled:
  - the clear face mask is the correct size and gives a good seal over the face and nose
  - the valve connection is correctly fitted and checked to be working
  - the self inflating bag is attached to oxygen at 15 l/min and the reservoir bag is filled with oxygen
- Standing at the head of the patient, place the clear face mask over the mouth and nose ensuring a tight seal around the mask. Hold the mask in place with one hand using your thumb and index finger to hold the mask on, with the remaining fingers along the mandible supporting the jaw. The patient is then ventilated by squeezing the bag.

Alternatively, **two people can use the equipment.** One person uses both hands to hold the mask on and support the jaw, whilst an assistant ventilates by squeezing the bag. **This is recommended for inexperienced operators.**

3.3.1.3 OXYGEN ADMINISTRATION

Most people with significant illness will benefit from the administration if oxygen. There are several options for the method of delivery and the one chosen is dependent on the needs of the particular patient. Delivery methods can be classified as:

- Fixed performance
- 100% Oxygen systems
- Variable Performance

FIXED PERFORMANCE SYSTEMS

There are two main types of circuits available:

1. Venturi mask
2. Masks using an oxygen blender to deliver specific concentrations of oxygen. These can deliver up to 100% oxygen.

- **Venturi Masks**

  Designed to deliver fixed concentrations of inspired oxygen. Best suited to lower concentrations of oxygen. There is an additional advantage of being partially humidified as the oxygen is mixed with air. Useful in certain categories of patients with COPD.

- **Oxygen Blender**

  Allows adjustment of the oxygen concentration accurately from 21-100% with or without humidification. Disadvantaged by lack of portability.

100% OXYGEN SYSTEMS

- **Non re-breathing circuits (avoid re-breathing CO2)**
  - Free flowing circuits, eg, oxygen blenders
  - Self refilling circuits eg Laerdal or Air Viva bags
  - Soft reservoir bags attached to oxygen masks incorporating simple valves
  - Oxygen powered resuscitators
- **Partial Re-breathing circuits**

  These are the circuits used in anaesthetics. The only one of these which is sometimes used in emergency settings is the Mapleson E or F (Ayer's T piece).

VARIABLE PERFORMANCE SYSTEMS

The oxygen concentration changes with the respiratory rate, tidal volume and inspiratory flow rates. Options are:

- Nasal cannulae
- Standard Hudson Mask
- T pieces

- **Nasal Cannulae**

  Deliver oxygen concentrations of 22-40%. Flow rates of > 4 l/min are not well tolerated due to drying of the nasal mucosa.

  Not recommended in dyspnoeic adults due to the small nasopharyngeal reservoir and the greater proportion of mouth breathing.

  Tends to be more efficient in children.

- **Standard Hudson Mask**

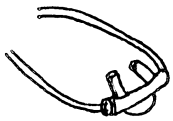
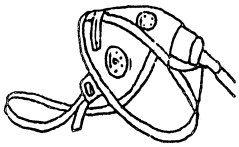
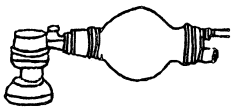
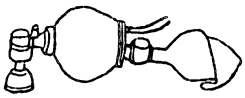
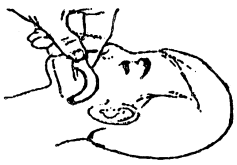
  At flow rates of 6-14 l/min delvers oxygen concentrations of 35-40%. Using a reservoir bag and one way valves on the sides of the mask (the non re-breather mask) allows an increase in delivered oxygen to as high as 90%. This is further improved if a second supply to the mask is used allowing delivery of 30 l/min.

- **T pieces or Y Connectors**

  These have a side arm in the system to allow :

  - Increased oxygen delivery
  - Humidification
  - Nebuliser medication without a period of decreased oxygen delivery.

OXYGEN AND AIRWAY ADJUNCTS

SYSTEM	ILLUSTRATION	O2 FLOW L/MIN	AMOUNT OF O2	USE
NASAL CANULA		1 to 6	24% to 44%	Suitable for patients who require minimal amounts of O2. Concentrations of O2 cannot be reliably determined as it is influenced by factors such as nasal resistance, oropharyngeal resistance, inspiratory flow rate and tidal volume.
SIMPLE FACE MASK		6 to 10	35% to 60%	Poorly tolerated by infants and toddlers but may be accepted by older patients. A minimum of 6 L/MIN O2 must be used to maintain an increased inspired O2 concentration and prevent re-breathing of exhaled carbon dioxide.
NON REBREATHER MASK		10 to 12	95%	The mask consists of: face mask; reservoir bag; two one way valves. One valve on the exhalation port to prevent entrainment of room air during inspiration and one valve between the mask and bag. **This mask is for patients requiring high concentration of O2.**
SELF INFLATING BAG-VALVE WITHOUT RESERVOIR		10 to 15	30% to 80% APPROXIMATELY 40%	O2 concentration is dependent on ventilatory rate and flow of O2 into the bag so the concentration O2 varies with the amount of room air that is entrained.
SELF INFLATING BAG-VALVE WITH RESERVOIR		10 to 15	90% to 100%	Provides a more consistent O2 concentration as 100% O2 is entrained into the bag from the reservoir.
ORAL AIRWAY				An oropharyngeal airway is indicate for use in an unconscious patient if maneuvers to open the airway (eg. head tilt-chin lift or jaw thrust) fail. This airway should not be used in a conscious or semi conscious patient as it may stimulate gagging and vomiting
NASAL AIRWAY				A soft plastic or rubber tube that provides a conduit for airflow between the nares and the posterior pharyngeal wall. Responsive patients better tolerate this airway.

3.4 IDENTIFICATION AND MANAGEMENT OF CHEST INJURIES

One out of every four trauma related deaths is attributable to chest injury. Many of these deaths can be prevented by prompt diagnosis and management. These injuries often occur some distance away from a trauma centre, making early diagnosis and management of these injuries very important. Most life threatening chest injuries can be managed by simple procedures within the capabilities of any doctor.

3.4.1 Pathophysiology

Tissue **hypoxia, hypercarbia and acidosis** are the physiological end stage results, all of which occur with extensive thoracic injuries.

HYPOXIA

By definition this is inadequate delivery of oxygen to the tissues of the body. (In the trauma patient, hypovolaemia due to blood loss will also contribute to hypoxia).

HYPERCARBIA

This constitutes an elevated concentration of CO2 in the blood, and therefore implies hypoventilation. Hypoventilation can be due to:

- a ventilation perfusion mismatch eg as a result of lung contusion, haematoma or alveolar collapse
- changes in intrathoracic pressure, eg tension pneumo/haemothorax, open pneumothorax.

ACIDOSIS

In the trauma patient this can be either **respiratory** due to hypoventilation and hypercarbia, or **metabolic** due to tissue hypoxia. Often both mechanisms are involved. Progressive acidosis will eventually lead to the shut down of various important biochemical actions in the body, resulting in multiple organ failure and death.

Interventions in the chest injured patient are designed to ensure the adequate delivery of oxygen from the lungs to the tissues.

3.4.2 Conditions in the trauma patient which may compromise breathing

3.4.2.1 CONDITIONS AWAY FROM THE CHEST :

- Head injuries, drugs and alcohol, all of which may lead to an altered level of consciousness
- The obstructed airway

3.4.2.2 CONDITIONS IN THE CHEST

- Tension pneumothorax
- Simple pneumothorax
- Open pneumothorax
- Massive haemothorax, simple haemothorax
- Cardiac tamponade

- Flail chest
- Fractures of the scapula, first and/or second ribs
- Other rib fractures
- Ruptured diaphragm

SIMPLE PNEUMOTHORAX

This is most commonly caused by lung laceration due to blunt trauma, but also frequently by penetrating injuries. Air collection in the pleural space collapses lung tissue. This causes a ventilation perfusion defect, as blood circulated to the non ventilated collapsed lung is not oxygenated.

Clinical Presentation

The patient has dyspnoea, ipsilateral decreased breath sounds with hyper-resonance. A chest X-ray (preferably upright) will confirm the diagnosis.

Treatment

Observation or mere needle aspiration may be easy, but also the risky way out. Instead the placement of a chest tube connected to an under water drain is recommended. This must be followed with a chest Xray to confirm re-expansion of the lung. Patients with traumatic pneumothorax must never undergo general anaesthesia or be transported via air ambulance before a chest tube has been inserted, because of the risk of a tension pneumothorax developing.

TENSION PNEUMOPTHORAX

This develops when air is forced into the thoracic cavity without any means of escape, resulting in the progressive collapse of the lung. The mediastinum and trachea become displaced to the opposite side, compromising venous return to the heart.

Common causes of tension pneumothorax include:

- mechanical ventilation (especially when making use of positive end expiratory pressure)
- spontaneous pneumothorax with rupture of emphysematous bullae which fail to seal.
- blunt chest trauma with injured lung paryncyma failing to seal
- penetrating chest injury, when a one way valve mechanism prevents air from escaping from the thoracic cavity.

Diagnosis

Though a **simple** pneumothorax may be clinically missed, only to be identified later on chest X-ray, the diagnosis of a **tension** pneumothorax must always be made on clinical grounds. Waiting for radiological confirmation may cost the patient's life.

Clinical features

- Pain
- Respiratory distress - increased respiratory rate, dyspnoea, use of accessory muscles of respiration, cyanosis (late manifestation)
- Hypotension - due to the decreased venous filling of the heart

- Tachycardia - compensatory
- Tracheal deviation - to the opposite side because of mediastinal compression
- Ipsilateral **hyperresonance** on percussion of the chest - this is the only sign differentiating tension pneumothorax from a massive haemothorax or a cardiac tamponade, which may both present with the same clinical features listed above.

Management

Requires immediate decompression with a large lumen needle through the second intercostal space in the mid clavicular line. Three to four small lumen needles may be used as a compromise in the absence of a large lumen needle. This procedure will convert the tension peumothorax into a simple pneumothorax, buying adequate time for the placement of a chest tube, or a Foley's catheter in the absence of a chest tube.

OPEN PNEUMOTHORAX

This condition is defined as a penetrating defect of the chest wall which remains open, causing immediate equilibration between intrathoracic and atmospheric pressures, thereby impairing ventilation and further leading to hypoxia.

Management

Prompt closure of the defect preferably with a sterile occlusive dressing large enough to overlap the wound edges. This dressing should be secured with tape to the patient's chest along three of its edges, leaving one of the edges open to form a so called flutter valve. This will ensure that that the dressing seals against the chest wall when the patient inhales, and allows air to escape through the open end when the patient exhales, thus preventing the development of a tension pneumothorax. Placing a chest drain and closure of the defect would be the definitive treatment method afterwards.

SUBCUTANEOUS EMPHYSEMA

This may be the result of an injury to the airways or lung parenchyma. No treatment is required as this will absorb in time. The underlying injury must however be addressed.

HAEMOTHORAX

This can be due to a laceration to the lung parenchyma, or the transection of an intercostal vessel or the internal mammary artery after blunt or penetrating trauma to the chest. Usually these haemorrhages are self-limiting and do not require operative intervention. However a haemothorax large enough to be seen on chest X-ray usually needs to be drained with a large calibre chest tube. Note that in an adult it takes approximately 300 ml of blood in the pleural cavity to eliminate the costophrenic angle on a standing chest X-ray.

Urgent thoracotomy is indicated when 1500 ml or more of blood drains initially, or with persistent drainage of 200 ml of blood per hour for 4 or more hours.

MASSIVE HAEMOTHORAX

This is defined as the rapid accumulation of 1.5 litres of blood in the pleural cavity. This condition is characterised by the clinical features of shock, dyspnoea, ipsilateral decreased breath sounds and **dullness** to percussion, while the trachea may be pushed to the contralateral side.

A massive haemothorax is usually the result of a penetrating chest injury, although it may also occur after blunt trauma to the chest.

Treatment

Treatment measures include the restoration of blood volume, followed by drainage of the haemothorax. Either Ringers lactate or normal saline solution can be used as resuscitation fluid, preferably via two large lumen intravenous lines. Blood must also be sent away for cross-matching, as transfusion will usually be required.

When inserting the chest drain, the largest calibre chest tube possible must be used to prevent clots of drained blood from obstructing drainage.

If an auto-transfusion device is available, it may be a very efficient way of restoring the patient's blood volume, making use of the patient's own drained blood.

Penetrating wounds to the anterior chest medial to the nipples, and posterior wounds medial to the scapula, should alert the attending physician to possible injuries to the greater vessels, hilar structures and the heart, and therefore the possible need for a thoracotomy.

CARDIAC TAMPONADE

This can result from penetrating and blunt chest trauma, causing injury to the great vessels or to the heart, leading to the accumulation of blood in the pericardial sac. Even a relatively small amount of blood in the sac will interfere with cardiac filling and activity.

Clinically this condition may present with Beck's triad consisting of:

- distended neck veins due to an elevated pressure in the superior vena vava
- pulsus paradoxus in excess of 10 mmHg
- muffled heart sounds

Another possible clinical finding may be the presence of pulseless electrical activity (PEA) of the heart, also known as electro-mechanocal dissociation (EMD). The ECG monitor continues to show electrical activity of the heart in the absence of palpable peripheral pulses. Small QRS complexes may also be seen on the ECG, owing to the insulating effect of pericardial blood.

Treatment

Failing response to fluid resuscitation in a suspected cardiac tamponade patient is an indication for pericardiocentesis. Extraction of blood, often as little as 15-20 ml of blood, may result in haemodynamic improvement. All patients with a positive pericardocentesis will require thoracotomy for inspection of the heart.

FLAIL CHEST

This condition is associated with chest trauma involving multiple rib fractures, resulting in a segment of the chest wall that has no bony continuity with the rest of the thoracic cage. This loose fragment of chest wall has paradoxical motion to the rest of the chest wall with inhalation and exhalation. On palpation crepitus of rib fractures aids the diagnosis.

The major concern in flail chest is the amount of contusion to the underlying lung, as this will play a major role in the development of hypoxia. Associated pain with restricted movement of the chest wall may further contribute to the development of hypoxia.

The mainstay of management is the prevention of hypoxia, which necessitates adequate ventilation using humidified oxygen. A short period of intubation and ventilation may be indicated.

Administration of analgesics (eg morphine 0.05 - 0.1 mg/kg IV) may also improve ventilation.

Fluid resuscitation must be judiciously administered as contused lung tissue is sensitive to both hypovolaemia and overhydration.

FRACTURES OF THE SCAPULA, FIRST AND SECOND RIBS

As with a flail chest injury, fractures of the scapula and the first or second ribs is evidence of severe force applied to the chest wall, and therefore the likelihood of injuries to the underlying tissues, organs and other structures listed below is great. Associated injuries which may occur:

- **Thoracic Cavity**
  - pulmonary contusion
  - myocardial contusion
  - aortic disruption
  - diaphragmatic rupture
  - oesophageal disruption
  - tracheobronchial disruption
- **other structures**
  - head injury
  - neck injury
  - spinal injury

Because of the severity of these associated injuries, the mortality can be as high as 50%.

An aortogram should ideally be performed on all patients injured in sudden acceleration or sudden deceleration accidents (especially motor bike accidents), to exclude subclinical aortic disruption.

OTHER RIB FRACTURES

The ribs are the most commonly injured component of the thoracic cage. Rib fractures may impair adequate ventilation because of pain on motion, which results in splinting of the thorax. There may also be impairment of the clearing of tracheobronchial secretions, leading to atelectasis and pneumonia.

The middle ribs (4-9) usually sustain the major force of blunt trauma and may be associated with underlying pulmonary contusion, pneumo and /or haemothorax.

Fractures of the lower ribs (10-12) should increase the physician's suspicion of hepatosplenic and renal injuries.

Localised pain, tenderness on palpation and crepitus warrants a chest X-ray, not only to identify a possible rib fracture, but more importantly to rule out other intrathoracic injuries. However, there is no need for special X-ray techniques to identify rib fractures not clearly seen on ordinary PA and lateral films of the chest, as it would not alter the management in any way.

In general, younger patients have more flexible chest walls, and are therefore less prone to rib fractures. The presence of multiple rib fractures in young patients implies greater impact than that needed to produce the same injury in older patients.

Any form of splinting of the chest wall is contraindicated. Relief of pain via systemic analgesics or an intercostal block would improve ventilation.

3.5 EMERGENCY PROCEDURES

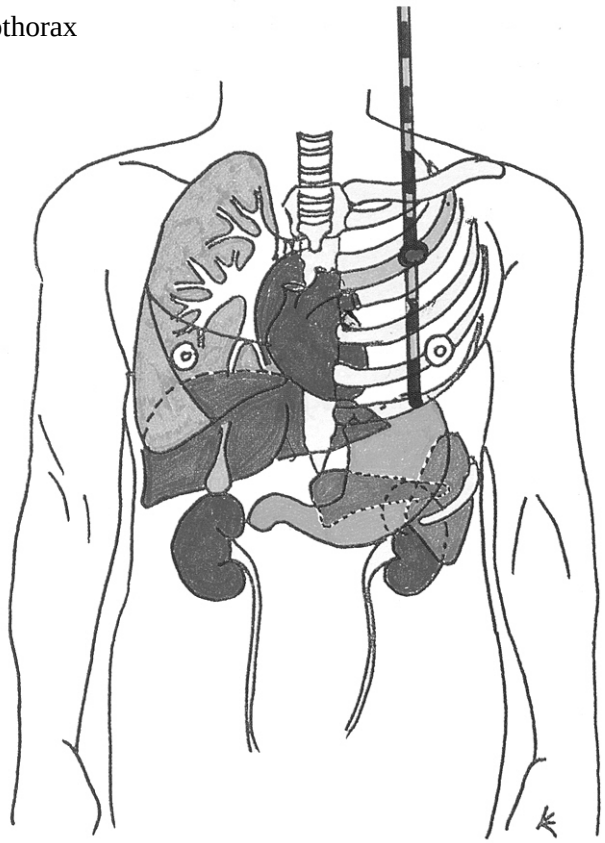
3.5.1 Needle decompression for tension pneumothorax

INDICATION

Life threatening tension pneumothorax

SITE OF PLACEMENT

In the mid-clavicular line of the second intercostal space



EQUIPMENT

A large lumen needle (14F)

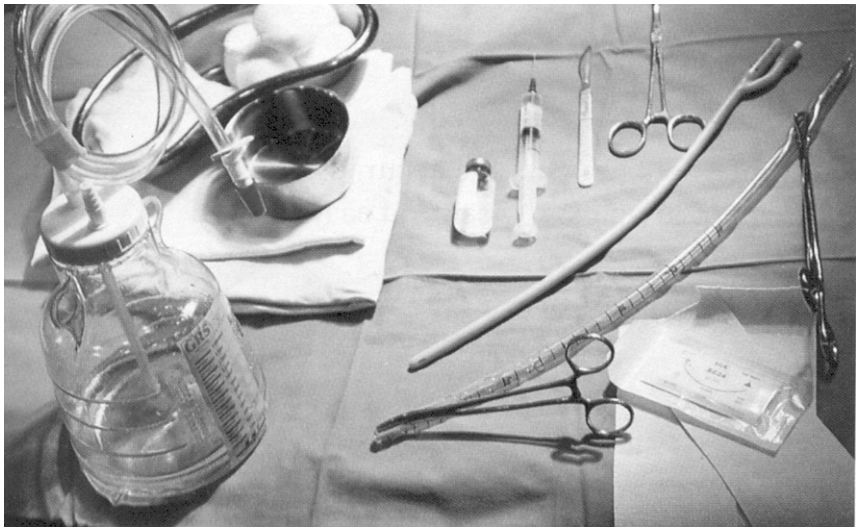
POSSIBLE COMPLICATIONS

- Local cellulitis / haematoma
- Pleural cavity infection
- Pneumothorax - if diagnosis of tension pneumothorax was wrong and needle was inserted into lung tissue

3.5.2 Chest tube insertion

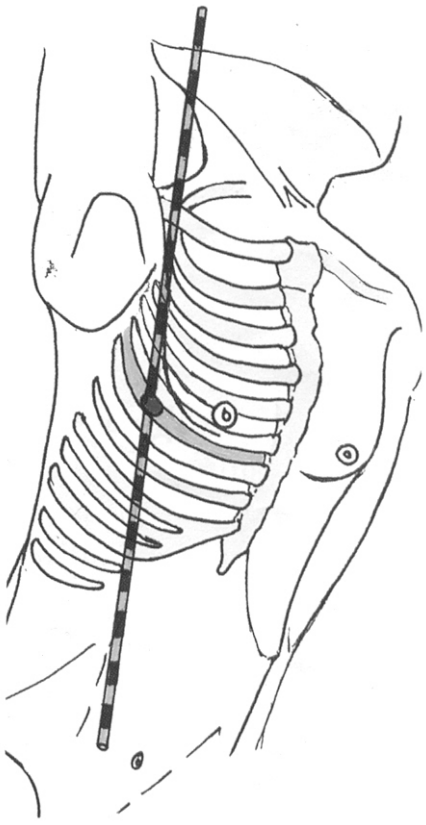
INDICATIONS

Haemo and or pneumothorax



EQUIPMENT

- Gloves and cleaning material
- Sterile linen for draping
- Local anaesthetic
- Surgical blade and scalpel
- Artery forceps (2)
- Chest tube
  - **haemothorax** : largest possible calibre chest tube eg F38
  - **pneumothorax** : any diameter chest tube, or a Foleys urinary catheter
- Underwater drainage bottle
- Suturing material eg silk 4-0
- Three plaster strips (approx. 20 cm long)



SITE OF PLACEMENT

- The classic site of placement of a chest tube for the drainage of both a haemo or pneumothorax is in the fifth intercostal space in the anterior axillary line (just behind the pectoralis major reflection line. In a male patient this site is easily identified as being just inferolateral to the nipple).
- For a pure pneumothorax, a chest tube or Foleys catheter may also be placed in the second intercostal space in the midclavicular line.

PROCEDURE

- Surgically prepare and drape the site of placement. Locally anaesthetise the skin and rib periosteum on both sides of the intercostal space.
- At the predetermined site, make a 2-3 cm incision parallel to the intercostal space, through the skin and 1-1.5 cm deep into the subcutaneous space and intercostal muscles. Stick to the upper edge of the lower rib to prevent injury to the neurovascular bundle of the upper rib. Using artery forceps, bluntly dissect through the rest of the intercostal tissue and puncture the parietal pleura. **Note that the use of a trochar is contraindicated**, because of possible penetration of underlying organs.
- Put a gloved finger through the incision to exclude any adhesions or clots.
- Clamp the proximal end of the chest tube with one pair of artery forceps using another pair to guide the front end of the chest tube into the thoracic cavity to a depth of 15-20 cm
- Connect the proximal end of the chest tube to an underwater drainage system and remove the distal artery forceps.
- Suture the tube in place and tape the tube to the chest
- Obtain a control CXR
- Note, especially when transporting the patient, not to lift the drainage bottle above the level of the chest, as this will cause the contents to flow back into the thoracic cavity.

POSSIBLE COMPLICATIONS

- local cellulitis or haematoma
- dislodgement of the chest tube from the chest wall or from the underwater drainage bottle
- kinking or clogging of the chest tube
- damage to the intercostal neurovascular bundle resulting in intrathoracic bleeding or intercostal neuralgia
- recurrence of pneumo and or haemothorax upon removal of the chest tube
- intra-abdominal placement of the tube with possible injury to the liver, spleen or kidney
- laceration or puncture of intrathoracic organs eg heart, oesophagus, aorta, lung etc. Both the latter complications can be prevented by correct site selection and using the glove-finger technique before insertion of the tube.

3.5.3 Pericardiocentesis

INDICATION

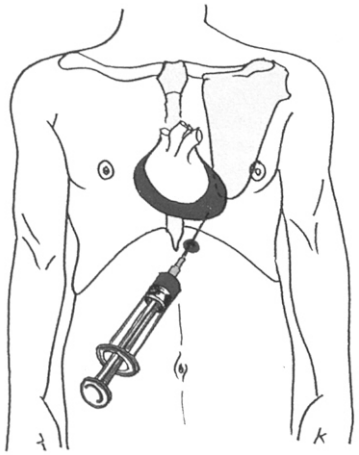
Cardiac tamponade

EQUIPMENT

- local anaesthetic
- # 16 (orange) or # 18 (green) intravenous over the needle catheter, connected to a 20 ml syringe
- a three way stopcock

SITE OF PLACEMENT

1-2 cm to the left of the ziphisternum in the left hypochondrium



PROCEDURE

- surgically prepare and drape the puncture site and infiltrate with local anaesthetic
- insert the needle through the skin at the puncture site and advance the needle forward aiming towards the lower tip of the left scapula, while pulling out the plunger of the syringe to apply suction.
- Aspirate as much blood as possible from the pericardial sac
- Remove the needle and syringe leaving the catheter in situ and securing it to the skin with plaster.
- Connect the 3 way stopcock (in the closed position) to the catheter for re-aspiration purposes, in case cardiac tamponade develops again.

POSSIBLE COMPLICATIONS

- Local cellulitis / haemotoma
- **Puncturing of :**
  - **myocardium** leading to possible ventricular fibrillation; ECG monitoring is advised
  - **coronary artery or vein**, possibly leading to a new haemopericardium
  - **lung** with possible haemothorax
  - **intercostal or great mediastinal vessels** with possible haemothorax
  - **oesophagus** with possible mediastinitis
  - **peritoneum** with possible peritonitis

3.5.4 Chest X-ray

OBJECTIVES:

- To be able to interpret the chest X-ray in **common emergency presentations**
- To recognize CXR abnormalities and understand their significance in emergency management
- To understand the limitations of the emergency mobile CXR

1. PNEUMOTHORAX

- clinical setting of chest pain and dyspnoea
- CXR shows lung edge with no lung markings beyond
- check for radiological signs of tension
  - trachea and mediastinum deviated to opposite side
  - flattened diaphragm
  - widening of rib spaces

2. LEFT VENTRICULAR FAILURE

- cardiomegally - cardiothoracic shadow of greater than 1/2 on PA film with good inspiration
- Kerley B lines - fluid in interlobular septa, seen as short horizontal lines at the periphery of the lung
- upper zone blood diversion ie vessels more prominent in upper zones of lungs
- pleural effusions with loss of diaphragm contour
- interstitial oedema with peri-bronchial cuffing
- alveolar oedema with opacification of air spaces

3. PNEUMONIA - VS- COLLAPSE

- consolidation with air bronchograms in pneumonia
- tracheal, mediastinal, septal, or fissure displacement in collapse

4. TRAUMA

- fractured ribs, clavicles, scapulae
- subcutaneous emphysema
- lung contusion
- evidence of mediastinal haemorrhage seen as widened mediastinum
- pneumothorax and or haemothorax
- ruptured diaphragm

5. HAEMOPNEUMOTHORAX

- pneumothorax with air fluid level on erect CXR
- **supine** CXR may **not** be diagnostic. The pleural margin may be obscured and up to 1 litre of blood may only show as haziness over the involved hemithorax.

6. POSITION OF ENDOTRACHEAL TUBE

- in trachea above carina ie at the level of the aortic arch, or the lower margin of the clavicles

7. POSITION OF INTERCOSTAL CHEST DRAIN

- in the thorax and not in the chest wall

8. POSITION OF NASOGASTRIC TUBE

- in stomach

3.5.4.1 CHEST X-RAY INTERPRETATION

CHEST X-RAY FINDINGS	DIAGNOSIS TO CONSIDER
Any rib fracture	◆ *Pneumothorax*
Fractures of ribs 1-3	◆ *Lung contusion, injuries to airways or greater vessels*
Fractures of ribs 9-12	◆ *Injuries to liver, spleen, kidneys, or other abdominal injuries*
Rib fractures in two or more places	◆ *Flail chest, pulmonary contusion*
Gastrointestinal gas pattern in chest(loculated air)	◆ *Diaphragmatic rupture*
Nasogastric tube in chest	◆ *Diaphragmatic rupture or ruptured oesophagus*
Air Fluid level in chest	◆ *Haemopneumothorax or diaphragmatic rupture*
Sternal fracture	◆ *Myocardial contusion, head injury, cervical spinal injury*
Mediastinal haematoma	◆ *Myocardial contusion, great vessel injury, sternal fracture*
Disrupted diaphragm	◆ *Abdominal visceral injury*
Respiratory distress without radiological abnormality	◆ *CNS injury, aspiration, airway obstruction*
Persistent large pneumothorax after chest tube insertion	◆ *Bronchial tear, oesophageal disruption*
Mediastinal air	◆ *Oesophageal disruption, tracheal injury*
Scapular fracture	◆ *Airway or great vessel injury, or pulmonary contusion*
Free air under the diaphragm	◆ *Ruptured hollow abdominal viscus*

3.6 OTHER RESPIRATORY EMERGENCIES

Isolated respiratory arrest or failure of ventilation in the presence of a clear airway and a central pulse can occur in the following circumstances:

1. poisoning with narcotic analgesics
2. general brainstem depression eg drugs, CVA, head injury
3. respiratory failure with CO2 narcosis ie a low PO2 and high PCO2
4. neuromuscular paralysis

Other **respiratory emergencies** to be considered include the following:

- Acute severe asthma
- Exacerbations of COPD

- Pneumonia
- Pulmonary embolism
- Pulmonary oedema

READING

1. **Emergency Medicine, Chris Moulton, David Yates 1999 Blackwell Science, ISBN 0-632-02766-5, Chapter 6 and 13**
2. **A Guide to Common Medical Emergencies in Adults WGJ Kloeck Sixth Edition 2002 ISBN 1-874856-20-6**

Chapter 4
CIRCULATION

OBJECTIVES

- Demonstrate competence in the diagnosis, treatment and management of cardiac and circulation emergencies including:
  - all forms of shock including hypovolaemic, cardiac, septic, neurogenic and anaphylactic
  - myocardial infarction
  - cardiac tamponade
  - arrhythmias
  - hypertensive urgencies and emergencies
- undertake the following basic skills
  - basic cardiac arrest protocol
  - advanced cardiac arrest protocol
  - defibrillation
  - emergency cardioversion
  - intraosseus needle insertion
  - venous cutdown
  - 12 lead ECG interpretation
  - use of fluid and blood resuscitation
  - administration of inotropes
  - antiarrhythmic therapy
  - needle pericardiocentesis

4.1 CIRCULATION: ASSESSMENT AND INITIAL MANAGEMENT

1. **Cardiac output**

   Determine the presence of carotid artery output by palpation of the femoral or carotid arteries (adults). Or brachial artery / apex beat (children).

   If no cardiac output is present, commence basic life support immediately.

2. **Measure the pulse rate and blood pressure** - using an appropriate size cuff (ie a bladder big enough to cover 2/3 of the upper arm)
   - Assessing what is a "normal" pulse rate and blood pressure - in the paediatric population is dependent on the child's age.
   - In adults, hypotension is a **relative term**, eg an elderly person whose blood pressure is 190/100 may be in shock with a BP of 120/80.

3. **Measure capillary refill** time in the finger tips. This should be <2 seconds.

   Additional parameters used for assessing the adequacy of circulation are urine output and mental state.

4. **Attach the patient to an ECG monitor** and determine the cardiac rhythm.

   - If VF or pulseless VT, defibrillate immediately.
   - Rhythm may be determined from the paddles on some defibrillators, if patient is not already on an ECG monitor.

5. **Insert IV cannula**

   A large gauge cannula (14 or 16) is required for rapid fluid resuscitation.

   If difficult in children, think of using intraosseus needle insertion.

6. **Take blood** from the cannula for appropriate tests, including crossmatch if trauma or haemorrhagic shock.

7. **If shock is present and hypovolaemic in origin, commence rapid fluid resuscitation** via a pump giving set, using crystalloid and colloid fluids. Give 10 - 20 ml/kg initially as bolus, increasing to 20 - 30 ml/kg if required. If further fluid is required, blood may be needed if haemorrhagic shock is present.

   Blood is available as packed cells.

   O negative can be used in an emergency. Otherwise cross-matched blood is used when available.

O negative = universal donor = immediately available	= 95% safe
ABO specific = available in 10 minutes	= 99.4% safe
Full X-match = 1 hour availability	= 99.95% safe

   (safety in terms of ABO Rh incompatibility reaction).

8. If shock is present after colloid infusion and the shock is thought to be **cardiogenic or septic in origin,** consider inotropes.

   - Central venous line insertion in this setting may be useful
   - In an emergency dobutamine can be commenced via a peripheral line. Other inotropes eg adrenaline / dopamine should preferably be given via a central venous line.

4.2 SHOCK

Shock is the result of an insult or injury to the circulatory system causing it to fail in its function to supply the tissue cells with oxygen and nutritional requirements and removal of toxic waste products.

The symptoms and signs of shock are those of tissue hypoperfusion and of physiological compensatory mechanisms. Compensation is a condition where these latter mechanisms temporarily stabilize shock. It should always be recognized and never left untreated. These compensatory mechanisms may be quickly depleted and lead to sudden cardiovascular collapse.

The **signs of shock** have been discussed above.

4.2.1 Symptoms of Shock

- Anxiety, confusion, delirium leading to unconsciousness caused by cerebral hypoxia.
- Palpitations due to tachycardia
- Shortness of breath caused by hypoxia and aggravated by hyperventilation
- Cold shivers due to peripheral vasoconstriction.

4.2.2 Pathophysiology of Shock

Hypotension and hypovolaemia invariably lead to hypoperfusion of tissue cells. This causes cellular injury and, accompanied by simultaneous hormonal and metabolic changes at cellular level, leads to an inability of the cell to utilize energy resources to maintain cell integrity. Eventually a stage is reached where lysosome rupture occurs with the release of enzymes that contribute to intracellular digestion and an increase of intracellular calcium. At this stage irreparable cell damage is established. If this condition is widespread through the tissues of vital organs, shock is established.

Hypovolaemia triggers a neuro-humoral response in the aorta and carotid arteries and in the mechanoreceptors in the right ventricle. This response leads to:

- increased sympathetic nervous system activity with direct cardiac stimulation and peripheral vasoconstriction
- increased pituitary release of adrenocorticotrophic hormone (ACTH) and antidiuretic hormone (ADH).
- increased adrenal gland release of noradrenaline and cortisol
- increased renin-angiotensin- aldosterone secretion.

The effect of these changes is an attempt to maintain blood pressure and volume. This constitutes the compensatory mechanism to combat shock. In the case of severe hypovolaemia this mechanism may be inadequate and organ damage will be inevitable.

Apart from these catecholamine hormones various other substances with vasoactive properties are released into the circulation in shock eg prostaglandins, serotonin, endorphans, proteases, platelet activating factors, leukotriones, interleukins etc. The precise role of these different substances in shock are not yet defined.

4.2.3 Specific Organ Involvement in Shock

THE HEART

Hypovolaemia results in poor coronary artery filling with a resultant decrease in myocardial perfusion and resultant myocardial dysfunction. This is aggravated by coronary artery disease, as is often the case in the elderly. Coronary ischaemia, hypoxaemia, adrenergic stimulation, drug toxicity and acidosis may all cause dysrhythmias and a resultant decrease in cardiac output.

THE BRAIN

The brain maintains an even perfusion distribution over a wide range of pressure levels. Below a systolic pressure of 60-70 mmHg the cerebral perfusion decreases and cerebral function deteriorates. As in the heart this is aggravated by existing cerebrovascular disease.

THE KIDNEYS

Oliguria is one of the cardinal features of shock. **Without oliguria the diagnosis of shock is in doubt.** Oliguria is not only due to poor renal perfusion, several mechanisms influence urinary output directly. Vasoconstriction of the afferent renal

arterioles results directly from reduced cardiac output, sympathetic stimulation, circulating catecholamines, angiotensin and prostaglandins.

Blood flow is directed from the cortical glomeruli to the medulla and the glomerular filtration rate decreases. This response may be aggravated by resuscitation measures like the use of vasopressor substances. Low doses of dopamine may counteract this and preserve renal output.

Acute renal failure is the end result of shock. Tubular necrosis, tubular obstruction by casts and cellular debris, and tubular endothelial damage are secondary manifestations of kidney damage.

THE LUNGS

Pulmonary oedema is often encountered and may be caused by cardiac failure, overhydration, increased vascular permeability and damage to the alveolar basal membrane.

THE LIVER

Ischaemia results in cellular damage with increased liver enzymes in the peripheral circulation. Damage also occurs to the reticuloendothelial system. Liver dysfunction results in defective inactivation of circulating catecholamines and so perpetuates shock.

THE GASTRO-INTESTINAL TRACT

Interstitial ischaemia causes intestinal fluid accumulation, mucosal necrosis and intestinal haemorrhage. The stomach is the primary site of damage and may lead to ulceration after normal circulatory function has been established.

4.2.4 Classification of Shock

Classification of shock tends to improve the understanding of the mechanism and pathophysiology as well as the basis of treatment.

1. **HYPOVOLAEMIC OR HAEMORRHAGIC SHOCK**

   The loss of volume in the circulation is the main feature in this type of shock. The loss may be caused by bleeding or plasma loss into the interstitium. In both instances a decrease in the intravascular volume is the result. Hypovolaemia or haemorrhagic shock is most often seen in trauma patients.

2. **CARDIOGENIC SHOCK**

   Decreased cardiac output is the main feature and may be caused by pump failure as in myocardial infarction or myocardial contusion, or by mechanical constriction as in cardiac tamponade, tension pneumothorax, or pulmonary embolism.

3. **NEUROGENIC SHOCK/SPINAL SHOCK**

   The main cause of hypoperfusion is the absence of vascular tone as is seen in spinal injury.

4. **SEPTIC SHOCK**

   The main cause is decreased vascular resistance, increased venous capacitance and arteriovenous shunting secondary to infection.

5. **ANAPHYLACTIC SHOCK**

   This is caused mainly by one or more of the following:

   - upper airway obstruction due to laryngeal oedema
   - lower airway obstruction due to bronchospasm
   - vascular collapse with hypovolaemia

We will now go onto discuss the different types of shock in more detail.

4.2.4.1 HYOVOLAEMIC SHOCK

DEFINITION

A clinical syndrome characterised by:

1. Depleted intravascular volume
2. Inadequate tissue perfusion (mottled skin, decreased level of consciousness, oliguria, acidosis)
3. Cellular hypoxia

CAUSES

1. Blood loss
2. Severe fluid loss eg dehydration, burns

CLINICAL FEATURES

A number of parameters are important (ie **not** just blood pressure)

1. **Pulse rate -** tachycardia is a reliable sign in the **young.** It is **not** so reliable in the elderly or in patients on beta blockers or calcium blockers.
2. **Blood pressure -** hypotension is a **late** sign. Postural hypotension should be sought as an early warning sign, especially in the young who have good compensatory mechanisms. Hypotension is a **relative** term. An elderly person whose usual blood pressure is 190/100 may be in shock with a BP of 120/80. An infant's normal BP may be 80/60.
3. **Capillary refill -** in shock is < 2 seconds in the finger tips.
4. **Evidence of inadequate tissue perfusion -** altered level of consciousness, oliguria, acidosis, and mottled skin.

An estimate should be made of % **Blood Volume Loss**

Normal blood volume: **Adults = 70 ml/kg**
Children = 80 ml/kg
Neonates = 90 ml/kg

CLINICAL CRITERIA IN SHOCK

Sign	**Hypovo-laemic**	**Cardiogenic: pump failure**	**Cardiogenic: mechanical**	**Neuro-genic**	**Septic**
Pulse rate	+	+	+	N or +	N or +
Blood pressure	-	- to N	-	-	-
Resp rate	+	+	++	N/+	++
Urine output	-	-	-	-	-
Neck veins	-	++	++	-	-
Skin temp	Cold clammy	Cold clammy	Cold clammy	Warm dry	Warm moist
CVP	-	+	++	-	N/-
Systemic vascular resistance	++	++	++	-	-
Volume response	+++	-	+	+	+

The shock index (SI = pulse rate/systolic BP) gives an indication of percentage blood loss:

SI < 1 blood loss < 25%

SI 1 - 1.5 blood loss 25 - 33%

SI 1.5 - 2 blood loss 33 - 50%

SI > 2 blood loss > 50%

Search for possible sources of blood loss (One on the floor and four more)

- On the floor - history from paramedics
- In the chest - heart, great vessels, or lung laceration : > 2 litres
  - ribs : 100 - 200 ml each
- In the abdomen - aorta, inferior vena cava, liver or spleen : > 2 litres
- In the pelvis - pelvic fractures : 1 - 3 litres
- In the thighs - femur fractures : 1 - 2 litres
  - other long bones : 0.5 - 1 litre

MANAGEMENT OF SHOCK

- **Control external haemorrhage**
  - direct pressure
  - elevation
  - pressure points (radial, brachial, femoral artery etc)
  - Mast suit of limited value in terminating arterial haemorrhage (inflated pressure 30 - 40 mm Hg)

- **Establish 2 large bore IV lines**

  14/16G cannula with high capacity administration set

- **Peripheral lines** are the first option with the least complications. Limbs with proximal long bone fractures must be excluded.

  In adults there are two alternatives if a peripheral site is not available or attempted unsuccessfully.

  1. **Venous cut down** requires the correct equipment and can be time consuming.
  2. **Central venous lines** carry an increased risk of complications and require more experience.

  In children less than 6 years of age there is one alternative if a peripheral site is not available, namely **intraosseus needle insertion.**

- **Obtain blood samples** for blood count, biochemistry and cross match. Pregnancy testing must also be considered in woman of child bearing age.

- **What to do when intravenous access is difficult**

  1. Intraosseus Puncture/Infusion (child)

  This procedure is **limited to children 6 years of age** or younger for whom venous access is impossible due to circulatory collapse.

  - Puncture site: anteromedial surface of the proximal tibia, approximately one finger-breadth (1-3 cm) below the tibial tuberosity.
  - If available, use either a bone marrow aspiration needle, an 18 gauge spinal needle with stylet, or an ordinary 14 to 16 gauge steel needle.
  - Use a gentle twisting or boring action, advancing the needle through the cortex into the bone marrow.
  - Attach a syringe with normal saline, gently withdraw on the plunger of the syringe. Aspiration of bone marrow into the syringe signifies entry into the medullary cavity. Inject the saline into the needle to expel any clot that may occlude the needle.
  - Proper placement is indicated if the needle remains upright without support.

  2. Long saphenous vein cutdown (adult)

  - Site: 2cm above and 2cm medial to the middle of the medial malleolus
  - Make a 2-3cm tranverse incision
  - Isolate and free the long saphenous vein for 2cm
  - Ligate the vein distally
  - Place a proximal ligature and leave untied
  - Make a transverse venotomy
  - Insert a cannula
  - Tie the upper ligature over the cannula
  - Close the skin and secure the drip tubing

4.2.4.2 SEPTIC SHOCK

DEFINITION

A clinical syndrome characterized by micro-organisms and/or their toxins in the blood. This results in decreased tissue perfusion and cellular hypoxia. **Hypotension is not always present.**

CAUSES

1. Most common - bacteria. Usually gram negative (eg E coli), but also gram positive (eg Staph aureus).
2. Uncommonly - fungi, viruses.

CLINICAL FEATURES

A number of parameters are important (ie not just BP)

1. **PULSE RATE -** tachycardia is not a reliable sign in the **young.** It is also not so reliable in the **elderly** or in patients on beta blockers, or calcium channel blockers.
2. **BLOOD PRESSURE -** hypotension is a **late sign.** Postural hypotension should be sought as an early warning sign, especially in the young who have good cardiovascular compensatory mechanisms. Hypotension is a **relative term** eg, an elderly person whose BP is usually 190/100 may be in septicaemic shock with a BP of 120/90. An infant's normal BP may be 80/60.
3. **CAPILLARY REFILL -** this may initially be normal with the patient being vasodilated and warm with a hyperdynamic circulation. However, as the disease progresses, the patient can enter the "cold stage: of shock. Patients with "cold" septic shock can easily be mislabelled as having cardiogenic shock, hypovolaemic shock or pulmonary embolus.
4. **EVIDENCE OF DECREASED TISSUE PERFUSION** - eg altered level of consciousness, oliguria, acidosis.
5. **TEMPERATURE** - patients may be febrile initially, but may be hypothermic in the later stage of "cold shock". Hypothermia is particularly common in the very young or the elderly patient in septic shock.
6. **HYPOGLYCAEMIA** - may be present, especially in the very young and the elderly.

IMPORTANT POINTS

1. Hypotension is a late sign.
2. Hypotension is relative to the patient's normal BP.
3. End stage septicaemic shock can be difficult to distinguish from other causes of shock. Septic shock should always be considered in any shocked patient where the cause is uncertain.

MANAGEMENT OF SEPTIC SHOCK

Initial Stabilization

1. **Position patient flat** if patient will tolerate.
2. **Airway -** keep patent.
3. **Breathing**

- Measure respiratory rate. If inadequate, assist ventilation with bag valve mask attached to oxygen.
- Measure SaO2. If < 95% and not requiring assisted ventilation, administer high flow oxygen via face mask.

4. Circulation

- Measure PR, BP and capillary refill
- Attach to a cardiac monitor and assess rhythm
- Insert IV cannulae (x 2)
- Take blood for cultures (x 2 at least), FBC, biochemistry, glucose, blood gases.
- Give crystalloid/colloid rapidly IV via a pump giving set.

5. Measure

- Finger prick blood sugar, especially in children and elderly. Give 1m/kg dextrose of hypoglycaemia is present.
- Temperature

Perform urinalysis (UTI is a common cause of sepsis in the elderly).

6. Monitor

ECG, SaO2, BP, urine output, temperature

Directed History and Examination

Ask about:

- **Event**
  - onset and duration of illness
- **Symptoms**
  - preceding symptoms (eg urinary, respiratory, CNS)
- **Past History**
  - diabetes
  - chemotherapy
  - previous antibiotic therapy
  - usual medications
  - allergies

Look for

- neck stiffness, lung signs, skin lesions
- exclude other causes of shock (eg blood loss, pulmonary embolus)

Measure

- response to initial fluid treatment, ie, measure PR, BP, capillary refill.

Tests

Complete the septic work up as appropriate eg CXR, urinalysis, stool culture, ABG's, LP.

Specific Treatment

1. Give antibiotics as early as possible.
2. Consider surgical intervention eg drainage of abscess, bypass for blocked ureter or bile duct if these are the origins of sepsis
3. If initial fluid bolus does not improve the shock and if there is no evidence of LVF, repeat IV fluids at half the volume of above should be given. If there is still no improvement, inotropes should be considered.

Disposition

1. Admit to an intensive care unit.
2. If patient is to be transferred, formal medical retrieval should be considered.

Important Points

1. Give antibiotics early

2. Early surgical intervention if indicated.

3. Give adequate volume replacement before commencing inotropes.

4. Exclude other causes of shock.

4.2.4.3 ANAPHYLACTIC SHOCK

DEFINITION

A syndrome of inadequate tissue perfusion resulting from acute hypersensitivity reaction to a foreign substance.

CAUSES

1. Drugs eg antibiotics
2. X-ray dyes
3. Foodstuff eg shellfish, strawberries, peanuts
4. Envenomation eg bees
5. Others

SHOCK is the result of a number of possible mechanisms:

- vasodilatation
- leaky capillaries
- cardiac inhibition

OTHER POSSIBLE MANIFESTATIONS OF ANAPHYLAXIS

RESPIRATORY	CARDIO-VASCULAR	SKIN	NEURO-LOGICAL	GIT
◆ Upper airway swelling or obstruction. ◆ Asthma.	◆ Tachycardia. ◆ Cardiac arrest.	◆ Urticaria. ◆ Generalised erythema. ◆ Angiooedema.	◆ Apprehension. ◆ Paraesthesia ◆ Fits	◆ Nausea / vomiting ◆ Abdominal pain

IMPORTANT POINTS

1. Shock is not the only manifestation of anaphylaxis.

2. Often the non-shock manifestations will predominate.

MANAGEMENT

Initial Stabilisation

1. **Remove causative agent**
2. **Position patient flat**
3. **Give Adrenaline**

   Route IM or small titrated amounts IV

   Dose **Adult** : 0.5 mg IM or 0.1 mg aliquots IV
   Child : 0.01 mg/kg (0.1 ml/kg 1: 1000) or 0.1 ml/kg of 1 : 10,000 IV
   Repeat as required

4. **Airway** - if the airway is at risk, eg stridor, hoarse voice, immediately call a doctor skilled in airway management.
5. **Breathing**
   - Measure RR. If inadequate, assist ventilation with bag valve mask attached to oxygen.
   - Measure SaO2. If < 95% and not requiring assisted ventilation, administer high flow oxygen via face mask.
6. **Circulation**
   - If in cardiorespiratory arrest, commence CPR
   - Measure PR, BP, capillary refill
   - Attach to a cardiac monitor and assess the rhythm. Correct any life threatening rhythm disturbances.
   - Inset IV cannula
   - Take bloods for baseline FBC, biochemistry
   - If hypotensive, give crystalloid/colloid rapidly IV via a pump giving set
7. **Disability**

   Measure Glascow Coma Score and pupil response. If GCS < 8, consider intubation to protect the airway
8. **Monitor** - ECG, SaO2, BP, temperature, blood sugar

Directed History and Examination

Ask about:

- **Event**

  Onset and duration of symptoms
- **Symptoms**

  CVS, respiratory, neurological, skin, GIT
- **Past History**
  - known precipitants
  - previous episodes
  - prior medical problems

Look for:

Non shock manifestations of anaphylaxis eg airway compromise, asthma, skin rashes, fitting

Measure:

Response to above treatment ie re-assess heart rate, BP, SaO2

Further Considerations

Treat other non shock manifestations of anaphylaxis eg nebulised ventolin for asthma

Disposition

1. Admit to a high care unit
2. Ensure adequate follow up, eg, self administration of adrenaline for further episodes, allergy tests
3. If patient transfer is to occur, consider medical retrieval if the patient is unstable or the airway is at risk, despite the above treatment.

Important Points

1. Adrenaline should be given as soon as possible. It is the drug of first choice and can be life saving.

2. The use of subcutaneous adrenaline should be limited to the non-shock manifestations of anaphylaxis eg urticaria.

3. Antihistamines and steroids are **not immediately life saving**. However, steroids may shorten the symptoms and help to prevent recurrence.

4.2.4.4 CARDIOGENIC SHOCK

DEFINITION

Inadequate tissue perfusion caused by poor cardiac pump function.

Characterized by:

1. Evidence of poor tissue perfusion:
   - cold clammy skin
   - capillary refill <2 seconds
   - poor urine output
   - altered level of consciousness
2. Hypotension

   This is a relative term eg an elderly person whose BP is 190/100 may be in shock with a BP of 120/80

This initially **may or may not** be accompanied by pulmonary oedema. This definition **excludes** serious arrhythmias as a cause.

CAUSES

1. Reduced Cardiac Contractility

- myocardial infarction
- myocarditis
- cardiomyopathy
- toxins or poisons eg drug overdoses, carbon monoxide poisoning

2. Inflow Obstruction

- pericardial tamponade
- mitral stenosis

3. Outflow Obstruction

- pulmonary embolism (right heart outflow obstruction)
- acute mitral or aortic regurgitation
- acute ventricular septal defect

IMPORTANT POINTS

A number of potentially reversible conditions can be easily mistaken for cardiogenic shock :

- hypovolaemia
- tension pneumothorax
- hypothermia
- drug toxicity
- septicaemia

MANAGEMENT

Initial Stabilisation

1. **Position patient flat** unless in pulmonary oedema, in which case sit the patient up.
2. **Breathing**
   - measure RR. If inadequate, assist ventilation with bag valve mask attached to oxygen.
   - Measure SaO2. If < 95% and not requiring assisted ventilation, administer high flow ventilation via mask.
3. Circulation
   - measure PR, BP, and capillary refill
   - attach to a cardiac monitor and assess rhythm. Correct any immediately life threatening rhythm disturbances.
   - take bloods for FBC, biochemistry, cardiac enzymes, blood cultures (x2) if sepsis is a possibility
4. Disability
   - record a GCS and pupil response. If GCS < 8, consider intubation to protect the airway.
5. **Perform :** a 12 lead ECG. If inferior myocardial infarct and if no pulmonary oedema is present, give 200 - 500 ml Hemaccel rapidly IV via pump giving set (An acute MI may involve the right ventricle and shock will respond to volume loading).
6. **Monitor -** BP, SaO2, urine output, temperature

Directed History and Examination

Ask about :

- **Event**
  - duration of illness
  - drug ingestion
- **Symptoms**
  - chest pain
  - dyspnoea
  - fever
- **Past history**
  - medications
  - other illnesses
  - known heart or valvular disease
  - allergies

Look for

Raised JVP, pulmonary oedema, new heart murmurs, other potential causes of shock eg infection, bleeding, tension pneumothorax

Tests

CXR, ABG's, blood cultures (x2) if sepsis is a possibility

Specific Treatment

1. If an acute MI is present, consider thrombolysis as per protocol
2. Treat pulmonary oedema as per protocol **but** withhold vasodilators and CPAP if BP< 100 systolic.
3. If an acute regurgitant murmur is heard contact specialist help
4. Commence Inotrope infusion if necessary
5. Early echocardiogram, if available

Disposition

1. Admit to high care unit for possible invasive monitoring and further inotrope therapy
2. If patient is to be transferred, consider medical retrieval.

Important Points

1. Do not mistake other types of shock for cardiogenic shock.

2. The prognosis for left ventricular acute MI with cardiogenic shock is very poor.

4.2.4.5 NEUROGENIC SHOCK

DEFINITION

Hypotension resulting from acute spinal cord injury (blocking sympathetic vascular tone).

Strictly speaking, this does **not fit the usual definition of shock** as it does **not** always result in decreased tissue perfusion.

CAUSES

Trauma to spinal cord causing arteriolar and venous dilatation below the level of the lesion.

Injuries involving the cervical cord can cause decreased sympathetic stimulation to the heart with resultant bradycardia.

CLINICAL FEATURES

1. Evidence or suspicion of spinal trauma
2. Moderate hypotension of 70-80mmHg with or without bradycardia
3. Warm, dry skin below the level of the lesion
4. Urine output is usually maintained
5. Priapism and a patulous anus may be present

IMPORTANT POINTS

1. Neurogenic shock does not fit the usual definition of shock because it does not always result in inadequate tissue perfusion

2. Another cause of shock with inadequate tissue perfusion may be hypovolaemic shock from e.g. associated traumatic rupture of the spleen.

MANAGEMENT

Initial Stabilisation

1. **Position patient flat and immobilize the spine**
2. **Airway - keep patent**
3. **Breathing -** may be compromised if there is a high cervical injury
   - Measure RR. If inadequate, assist ventilation with a bag valve mask attached to oxygen.
   - Measure SaO2. If < 95% and not requiring assisted ventilation, administer high flow oxygen via mask.
   - If intubation of a patient with a cervical spine injury is required, call a doctor skilled in airway management. Special techniques for intubation may be required to avoid movement of the neck.
4. **Ciculation**
   - Measure PR, BP, capillary refill
   - Attach to a cardiac monitor and assess the rhythm
   - Insert IV cannula
   - Take bloods for FBC, biochemistry

- IV fluid is not usually necessary in great quantity, provided there is no other cause of shock (eg ruptured spleen). A lower blood pressure is usually well tolerated in neurogenic shock.

5. **Disability**

   Record a GCS and pupil response. If GCS < 8, consider intubation to protect the airway.

6. **Monitor -** ECG, SaO2, urine output, temperature

Directed History and Examination

Ask about :

- **Event**
  - mode of onset
  - trauma
- **Symptoms**
  - back pain
  - paralysis
- **Past History**
  - previous illnesses
  - medications
  - allergies

Look for

1. Spinal injuries with neurological deficit
2. Paraplegia, quadriplegia, warm, dilated peripheries with hypotension and relative bradycardia, priapism, evidence of neck/back trauma (immobilise the spine and log roll the patient)
3. Evidence of other injuries
4. Evidence other causes of shock eg ruptured spleen

Tests

Xrays of spine.

If indicated, tests to exclude other causes of shock: CXR, Chest and Abdominal CT scan, ABG'S to assess adequacy of ventilation with a high cervical lesion.

Specific Treatment

1. Insert a nasogastric tube as acute gastric dilatation can occur.
2. Keep the patient warm (patients with a spinal injury can lose heat rapidly)
3. Analgesia for back /neck pain
4. Antiemetics if necessary
5. Early involvement of a surgeon if hypovolaemia is present or suspected as well (eg ruptured spleen, haemothorax)

Disposition

Early referral to a spinal unit.

Important Points

Consider other causes of shock in a trauma patient and exclude and treat these causes before diagnosing neurogenic shock.

4.2.5 Other Cardiovascular Emergencies

4.2.5.1 CARDIAC ARREST

You are expected to be able to verbalise and demonstrate an approach to the diagnosis and management of cardiac arrest, using the following algorithms:

- **Universal Basic Life Support Algorhithm**
- **Universal Advanced Life Support Algorithm**

4.2.5.2 MYOCARDIAL INFARCTION

BASIC ECG INTERPRETATION

The normal ECG complex :

P wave represents the depolarization of both left and right atria.

PR segment represents the electrical impulse spreading to the A V node, His bundle and bundle branches.

QRS complex represents the depolarization of both ventricles.

ST segment represents the early ventricular repolarization.

T wave represents the late phase of repolarization of the ventricles.

J point is the junction of the QRS and ST segment.

U wave follows the T wave.

Systematic approach to ECG interpretation

Three steps should be adopted in the examination of a standard 12 lead ECG: documentation, recording quality and interpretation.

Documentation

The name of the patient, date and the time of recording of the ECG must be recorded to give meaning and time frame to interpretation.

Quality

If base line drift is present interpretation of ST segments is difficult. Skeletal muscle or mains electrical interference can similarly affect ST segment evaluation. The calibration signal should also be checked before analysis is attempted.

Interpretation

The ECG machine measures the magnitude and type of electrical activity within the heart.
Interpretation therefore requires analysis of the rhythm and morphology of the patterns evoked.

Rhythm

This reflects the frequency and time relationships of atrial and ventricular depolarisation. The P waves and QRS complexes are used to determine normal rhythm and its disturbances.

Criteria for sinus rhythm

- P waves must be present and regular
- Their wave form should be consistent
- The frequency of P waves should be between 60 and 100 per minute
- Each P wave should be followed by a QRS complex. The PR interval should be within normal range and constant.

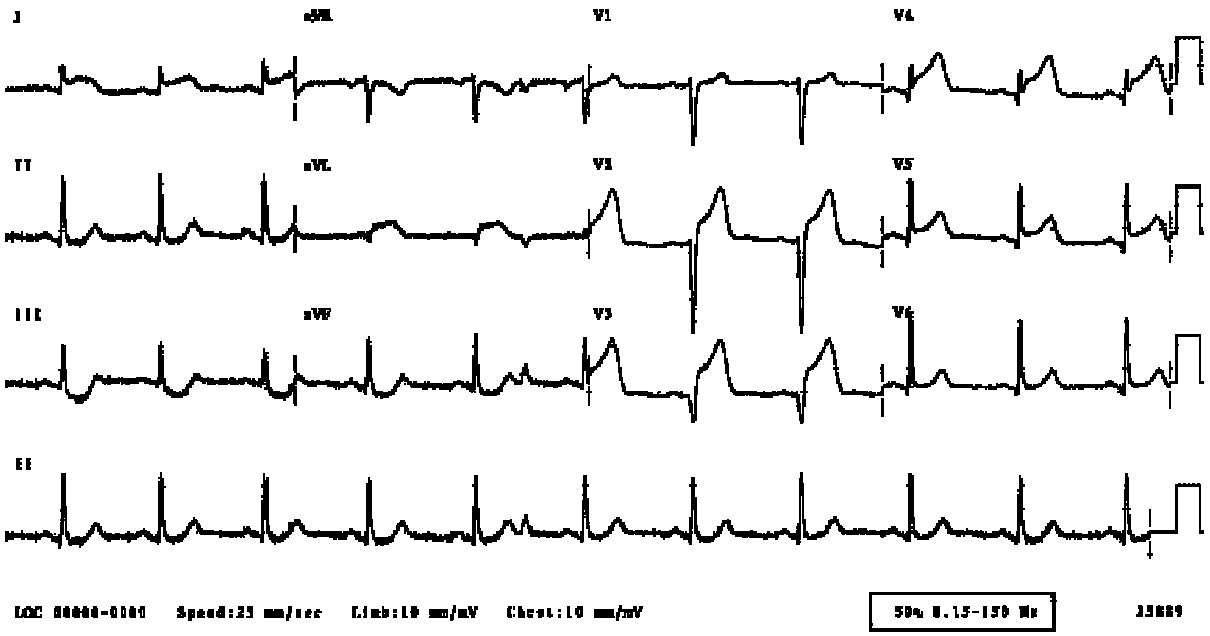
Measurement of rate

Each l mm square on the ECG paper represents 0.04 seconds and each larger square of 5 mm length represents 0.20 seconds. It therefore follows that 300 of the 5 mm blocks make up the duration of 1 minute.

The heart rate may be calculated by dividing the number of 5 mm squares (0.2 seconds) constituting the RR interval and dividing this into 300; this will give the rate per minute.

Another method would be to count the number of RR or PP intervals over a 3 second period (l5 x 5 mm blocks) and to multiply this number by 20 to calculate rate per minute. This method is useful for irregular rhythms.

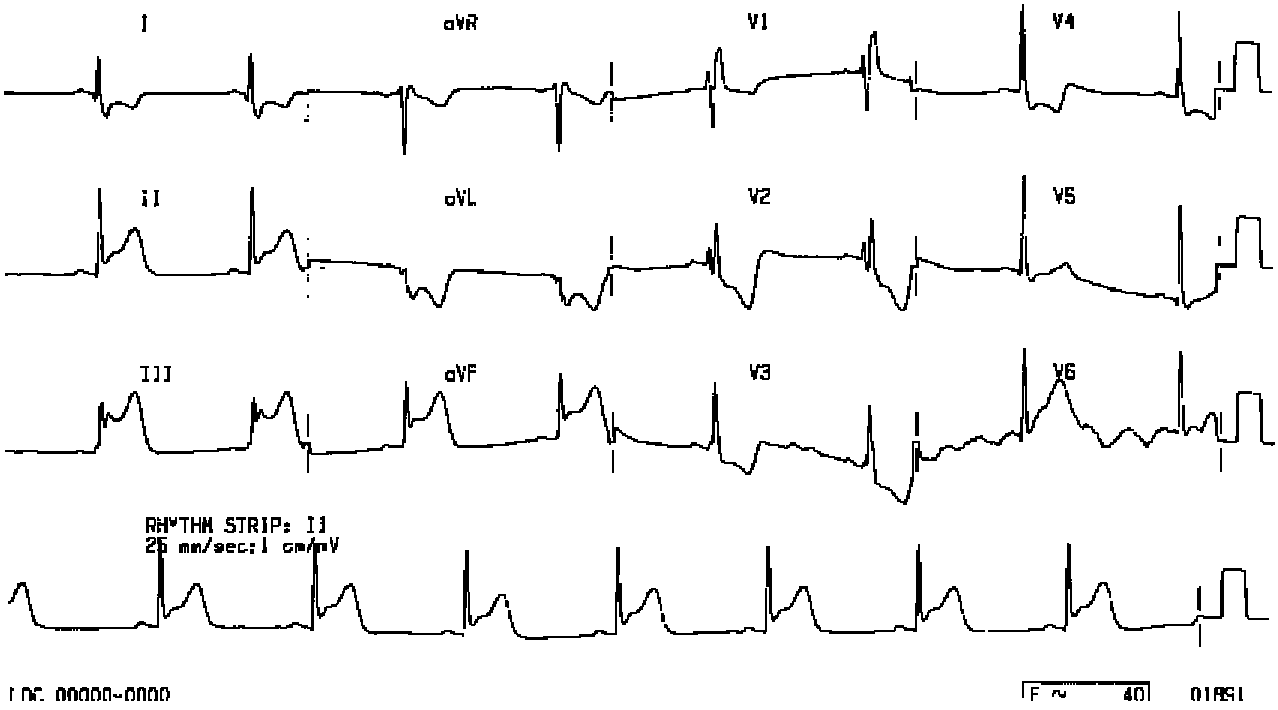
CASE 1: A 63 year old woman with 10 hours of chest pain and sweating.



ACUTE ANTERIOR MYOCARDIAL INFARCTION

- ST elevation in the anterior leads V1 - 6, I and aVL
- reciprocal ST depression in the inferior leads

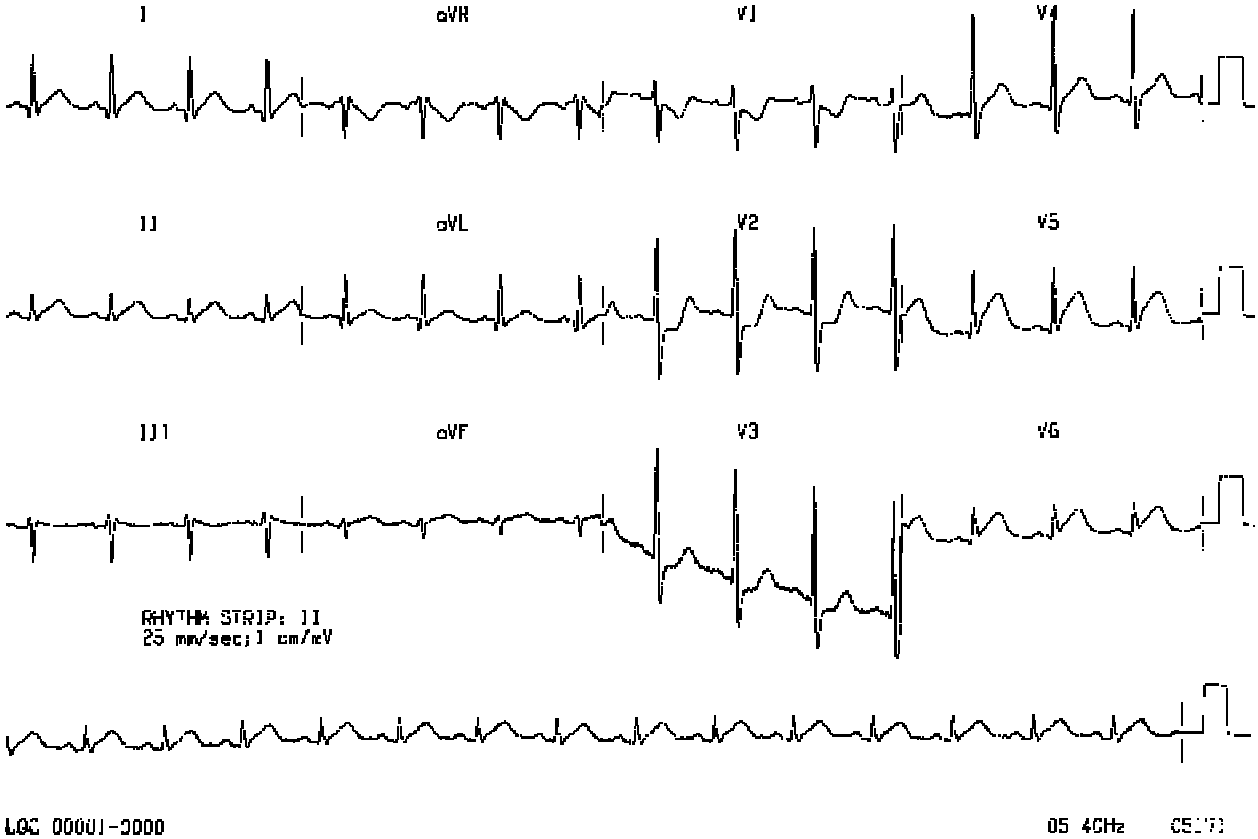
CASE 2: A 55 year old man with 4 hours of "crushing" chest pain.



ACUTE INFERIOR MYOCARDIAL INFARCTION

- ST elevation in the inferior leads II, III and aVF
- reciprocal ST depression in the anterior leads

CASE 3: A 60 year old woman with 3 hours of chest pain.



ACUTE POSTERIOR MYOCARDIAL INFARCTION

- (hyperacute) the mirror image of acute injury in leads V1 - 3
- (fully evolved) tall R wave, tall upright T wave in leads V1 -3
- usually associated with inferior and/or lateral wall MI

DEFINITION OF MYOCARDIAL INFARCTION

Occlusion of a coronary artery leading to myocardial injury or infarction.
Acute myocardial infarction is a common problem that leads to death in about 40% on untreated patients in the first 4 weeks following the infarct. Fifty percent of these deaths occur within 2 hours of the onset of symptoms.

CAUSES

1. Thrombosis in a coronary artery formed acutely on a pre-existing atherosclerotic plaque.
2. Uncommon : - aortic dissection
   - drugs (cocaine)
   - trauma

PREDISPOSING FACTORS

1. Increasing age
2. Cigarette smoking
3. Hypertension
4. Diabetes
5. Family history of ischaemic heart disease
6. Hyperlipidaemia

CLINICAL FEATURES AND ECG CHANGES

Need **at least two** of the following

1. **More than 30 minutes** of ischaemic cardiac chest pain
2. **ECG changes -** ST elevation of at least 2mm in two consecutive leads, or 1mm in two limb leads. The ECG can be normal initially.

   The part of the heart that is infarcting can be determined from the ECG using the following table :

LOCATION OF INFARCTION	LEADS
	Typical changes (Q waves, ST elevation and T wave changes)
◆ Anteroseptal	V_1, V_2, V_3
◆ Anterolateral	V_4, V_5, V_6, I and AVL
◆ Anterior	some of group V_1-V_3 plus some of group V_4-V_6
◆ Extensive anterior	V_1-V_6, I, AVL
◆ Interior infarction	II, III, AVL
◆ Posterior	V_1, V_2,

3. **Elevation of cardiac enzymes** which are released from dead myocardial tissue.

IMPORTANT POINTS

1. The initial ECG can be normal in an acute MI. These patients are in a good prognostic group and do not benefit from thrombolysis.
2. The initial cardiac enzymes levels in the blood may be normal and this test should **not** be used to exclude an initial diagnosis of AMI.

MANAGEMENT

Initial Stabilisation

- Positioning of patient
- Airway
- Breathing
- Circulation
- Disability
- Perform 12 lead ECG

Directed History and Examination

Ask about :

- **Event**

  Onset, duration, nature of pain

- **Symptoms**

  Any associated shortness of breath, dizziness sweating, palpitations

- **Past History**
  - Previous episodes, previous thrombolysis
  - Medications
  - Allergies
  - Other illnesses
  - Contraindications to thrombolysis

Look for

Poor peripheral perfusion, cardiac failure, arrhythmias, new murmurs, evidence of bleeding disorders

Measure

Temperature

Tests

CXR is only useful if aortic dissection or pneumothorax are possible diagnoses.

Specific action

Early, complete and sustained reperfusion of the infarct related artery remains the most crucial factor in preventing death and impairment of cardiac function following myocardial infarction.

The importance of thrombolytic therapy (within 12 hours of onset of chest pain with either ST segment elevation or new left bundle branch block) in reducing mortality has been well established.

In myocardial infarction with cardiogenic shock immediate primary percutaneous coronary angioplasty (PTCA) is the management of choice. If not available, one should give thrombolysis. At best complete patency at 90 min of the infarct related artery is only achieved in 54% of patients who are given thrombolytic treatment. The high rate of early and late reocclusions and persistent residual stenosis in a substantial number of patients also influences the effectiveness of thrombolytic therapy.

1. **Morphine** - 2-5 mg aliquots
2. **Oxygen**
3. **Nitrates** (not if BP<110). May start with sublingual or nasal spray, can use infusion if necessary.
4. **Aspirin** - 150 mg immediately unless contraindicated (allergy, bleeding). Aspirin alone saves as many lives as streptokinase alone.
5. **Thrombolysis**

   Must be given as early as possible, ideally within 1 hour of the onset of the pain and preferably within 4 hours

   - ***Indications for thrombolysis***

     Clear evidence of acute MI ie

     - >30 min, <12 hours of ischaemic chest pain **and**
     - new ST elevation of at least 2mm in two consecutive chest leads or 1mm in two limb leads
     - new LEFT BUNDLE BRANCH BLOCK

   - ***Contraindications***

     Risk of bleeding - active peptic ulcer disease

     - major trauma or surgery in last 2 weeks
     - haemorrhagic stroke within last 6 months or thrombo-embolism within last 6 weeks
     - prolonged traumatic CPR in last 2 weeks
     - recent active bleeding in non- compressible sites eg retina, nose, tongue
     - any previous use of streptokinase (use TPA instead)

   - ***Choice of agent***

     Use streptokinase as the standard agent unless:

     - its been used before
     - BP<100 systolic
     - Anterior acute MI where >4 hours of chest pain and patient's age <75

     (Use TPA for these situations)

   - ***Dosage Regimes***

     Streptokinase - Add 1.5 million units to 100 ml of 5% Dextrose water and infuse IV over 60 minutes.

     TPA (Recombitant Tissue Plasminogen Activator) - Give 15mg bolus IV, then 0.75mg per kg IV infusion over 30 minutes (not to exceed 50mg), then 0.5mg per kg IV infusion over 60 minutes. Total dose less than or equal to 100mg.

- ***Possible causes of Hypotension during Streptokinase therapy***
  1. Kinin release (commonest) - slow the infusion
  2. Arrythmia - usually transient, slow the infusion
  3. Cardiogenic shock - continue infusion
  4. Bleeding (uncommon during infusion) - cease infusion. Further thrombolysis contraindicated. Transfuse fluids, blood/blood products as appropriate.
  5. Anaphylaxis - cease streptokinase. Treat anaphylaxis. Change to TPA.

6. Heparin

If streptokinase has been given, start subcutaneous heparin 12,500 units bd 4 hours after the streptokinase. If TPA has been given, commence heparin immediately with a bolus of 5,000 units and an infusion of 15,000 units over 24 hours. Check the APTT 6 hours later and adjust the dose to achieve an APTT of 1.5 times normal.

7. IV Beta Blocker

Decreases mortality by limiting infarct size, reducing myocardial rupture rate, reducing tachyarrythmias, and reducing intracerebral haemorrhage in patients who have received thrombolysis.

- Contraindications
  Heart rate <60/min, BP < 100 systolic, asthma, heart failure, heart block, current use of calcium blockers eg Verapamil
- Dose regime - Atenolol 2-5 mg IV, repeat at 5-10 minute intervals (total dose 15mg). Monitor pulse and blood pressure between boluses.

8. ACE inhibitors

Generally not initiated in the Emergency Department.

Disposition

Admit to a coronary care unit.

Important Points

1. Aspirin alone saves as many lives as streptokinase alone.

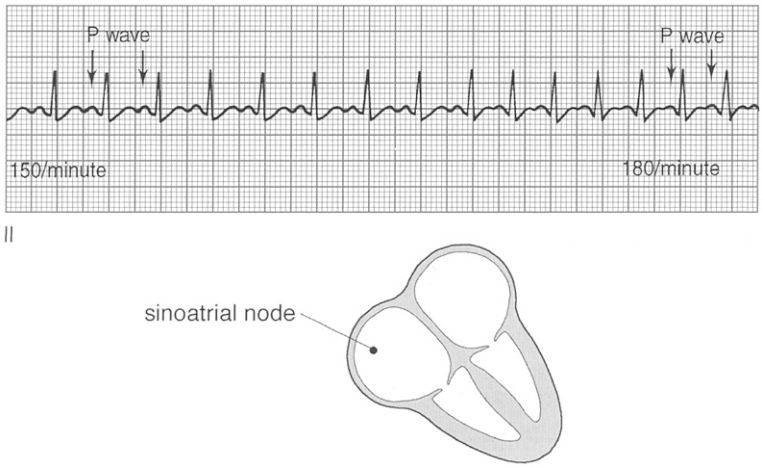
2. When thrombolysis is indicated, the earlier it is given, the better.

FURTHER READING :

EMERGENCY MEDICINE by Moulton and Yates, Chapter 12, pages 160-171

4.2.5.3 ARRHYTHMIAS

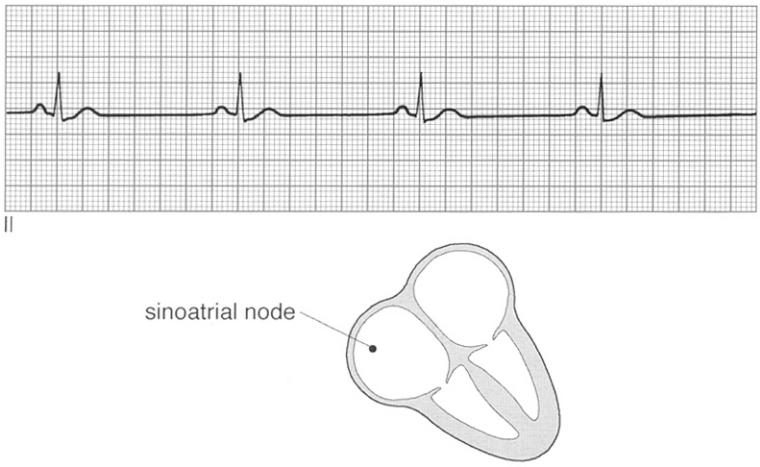
CASE 1: Sinus Tachycardia



SINUS TACHYCARDIA

- P wave rate greater than 100 bpm
- Heart rate is 150-180 beats/min
- P waves are upright (lead ll)
- QRS complex after every P wave

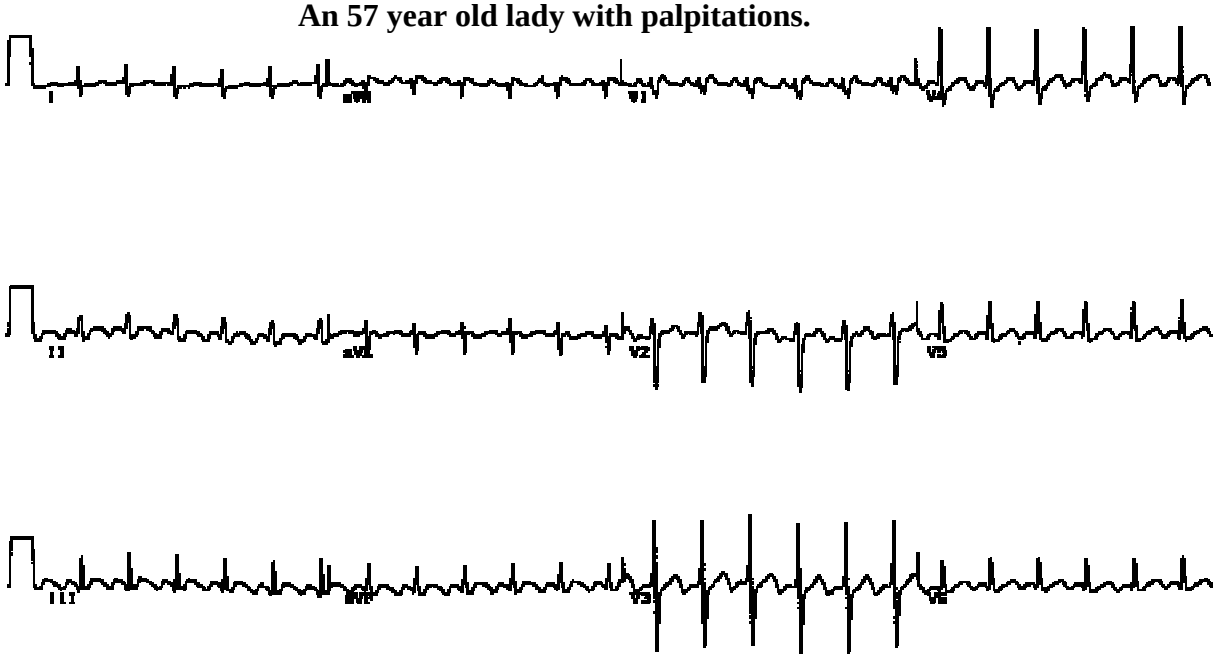
CASE 2: Sinus Bradycardia



SINUS BRADYCARDIA

- Heart rate is 43 beats/min
- P waves are upright (lead ll)
- QRS complex after every P wave

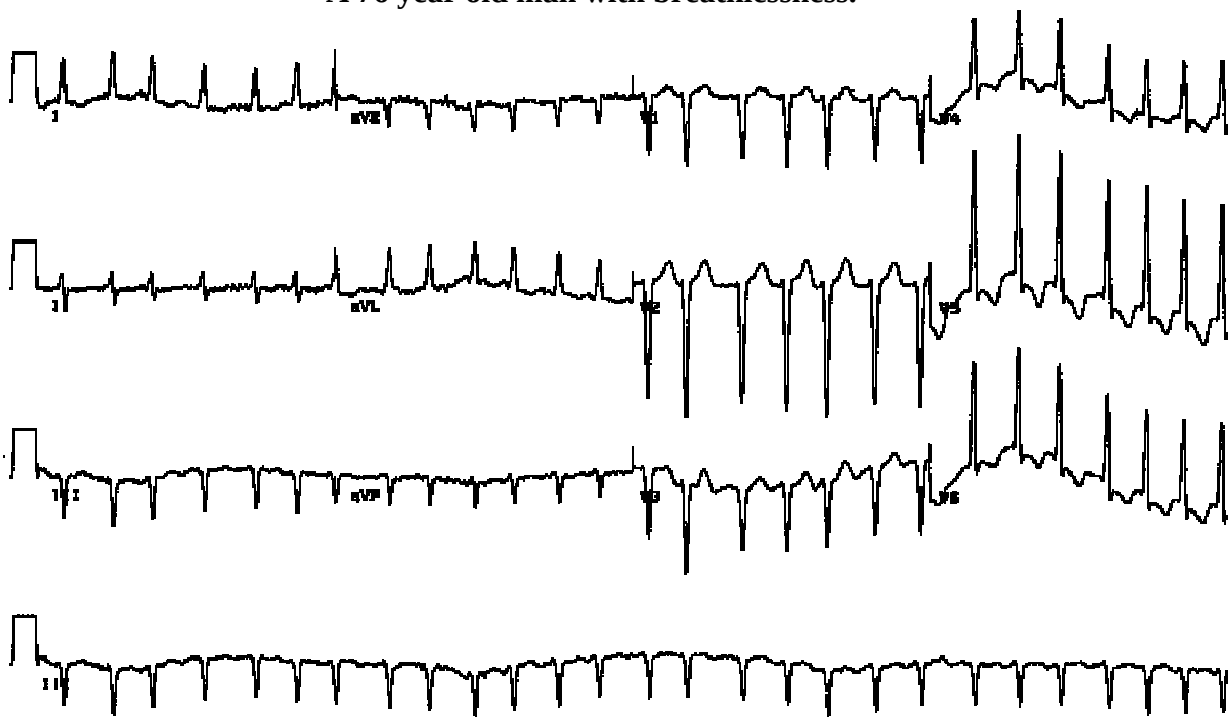
CASE 3: Atrial Flutter
An 57 year old lady with palpitations.



ATRIAL FLUTTER WITH 2:1 AV CONDUCTION

- The sawtooth waveform of atrial flutter can usually be seen in the inferior leads II, III and aVF if one looks closely. Sometimes the rapid atrial rate can be seen in V1.
- Suspect atrial flutter with 2:1 block when you see a rate of about 150 bpm. The atrial rate is shown to be twice the ventricular rate in the figure above.

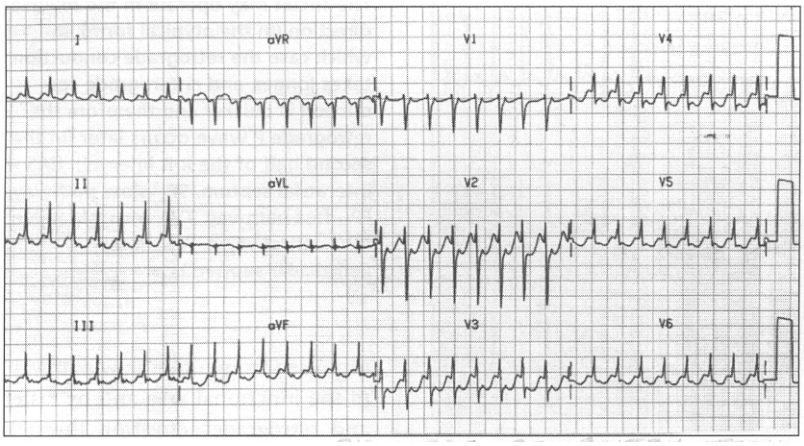
CASE 4: Atrial Fibrillation
A 76 year old man with breathlessness.



ATRIAL FIBRILLATION WITH RAPID VENTRICULAR RESPONSE

- Irregularly irregular ventricular rhythm.
- Sometimes on first look the rhythm may appear regular but on closer inspection it is clearly irregular.

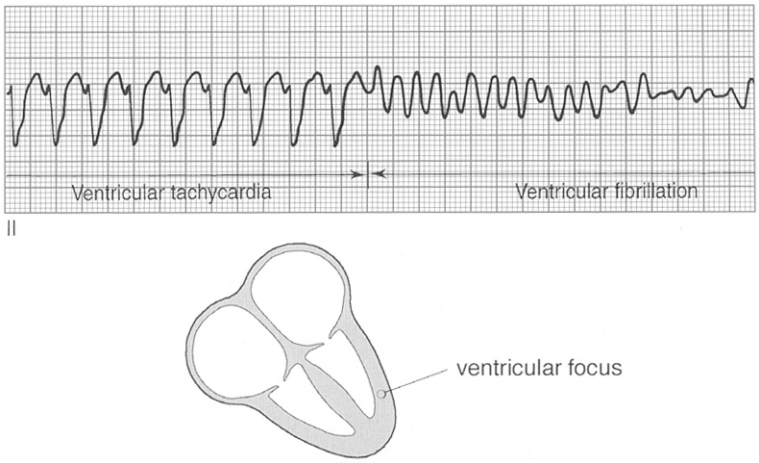
CASE 5: AV Node re-entry Tachycardia
A 45 year old lady with palpitations and history of chronic renal failure



AV NODE RE-ENTRY TACHYCARDIA

12-lead ECG of tachycardia in a patient with AVNRT. The ECG during this symptomatic episode shows a regular, narrow-complex tachycardia with a rate of 200 beats per minute

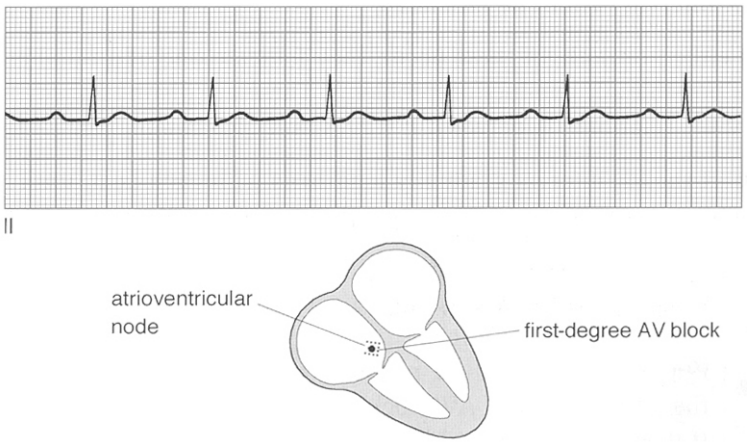
CASE 6: Ventricular Tachycardia



VENTRICULAR TACHYCARDIA

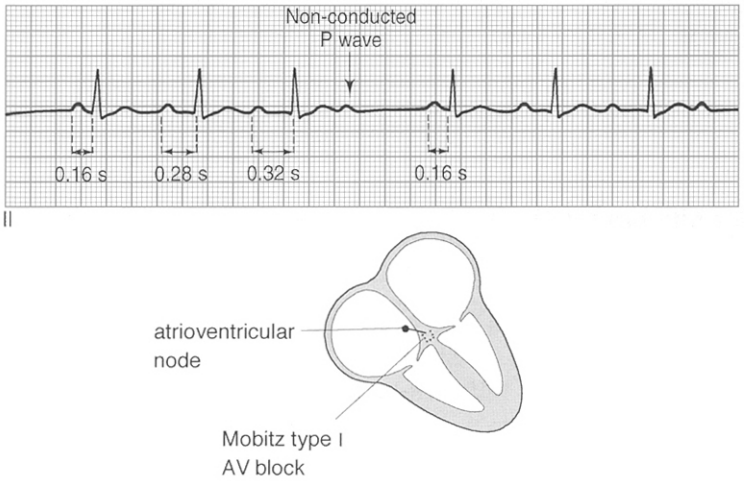
- broad-complex tachycardia at a rate of 190/min (VT)
- degenerates into chaotic rhythm (VF)

CASE 7: 1st Degree Heart Block



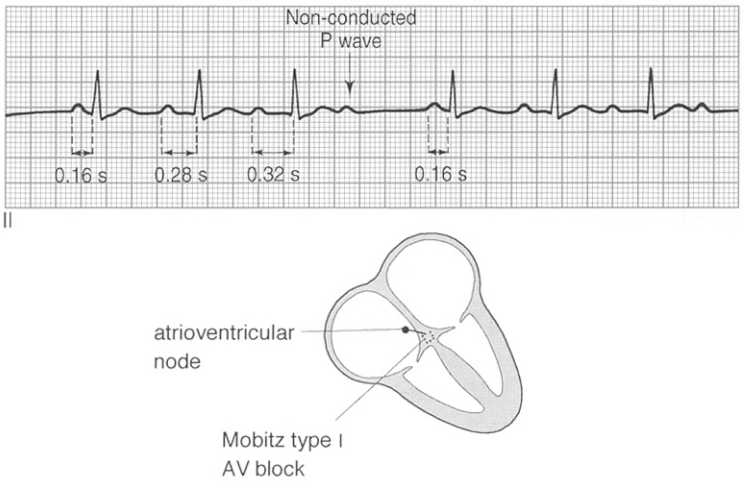
- long PR interval (0.31 secs)

CASE 8: AV Block, Mobitz Type I



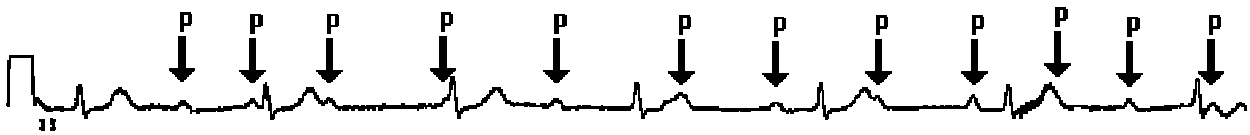
- progressive lengthening of PR interval
- a P wave then fails to be conducted
- PR interval resets and cycle repeats

CASE 9: AV Block, Mobitz Type II



- PR interval normal and constant
- an occasional P wave fails to be conducted

CASE 10: 3rd Degree Heart Block



COMPLETE HEART BLOCK

- P waves are not conducted to the ventricles because of block at the AV node. The P waves are indicated above and show no relation to the QRS complexes. They 'probe' every part of the ventricular cycle but are never conducted.
- The ventricles are depolarised by a ventricular escape rhythm.

DEFINITION OF ARRYTHMIAS

An abnormal cardiac rhythm giving a heart beat which is abnormally fast or slow, regular or irregular

CAUSES

1. Idiopathic
2. Ischaemic heart disease
3. Structural heart disease eg valvular heart disease, cardiomyopathy, myocarditis, rheumatic heart disease
4. Drug toxicity
   - Prescription drugs eg anti-arrhythmics, digoxin (especially in the presence of hypokalaemia)
   - Recreational eg cocaine
   - Intentional eg tricyclic overdose, organophosphates
5. Electrolyte disturbance eg hyper and hypokalaemia
6. Acid base disturbance
7. Hypoxia
8. Hyperthermia
9. Others eg thyrotoxocosis, raised intracranial pressure

CLINICAL FEATURES AND ECG CHANGES

- Patient is in cardiac arrest
- Patient is partially compromised
- Patient is not compromised

MANAGEMENT

Initial Stabilisation

- Position patient
- Airway
- Breathing
- Circulation
- Consider immediate Synchronised Cardioversion where indicated
- Consider Atropine if bradycardia is present
- Record GCS and pupil response
- Monitor ECG, SaO2, BP

Directed History and Examination

Ask about

- Event
- Symptoms
- Past History

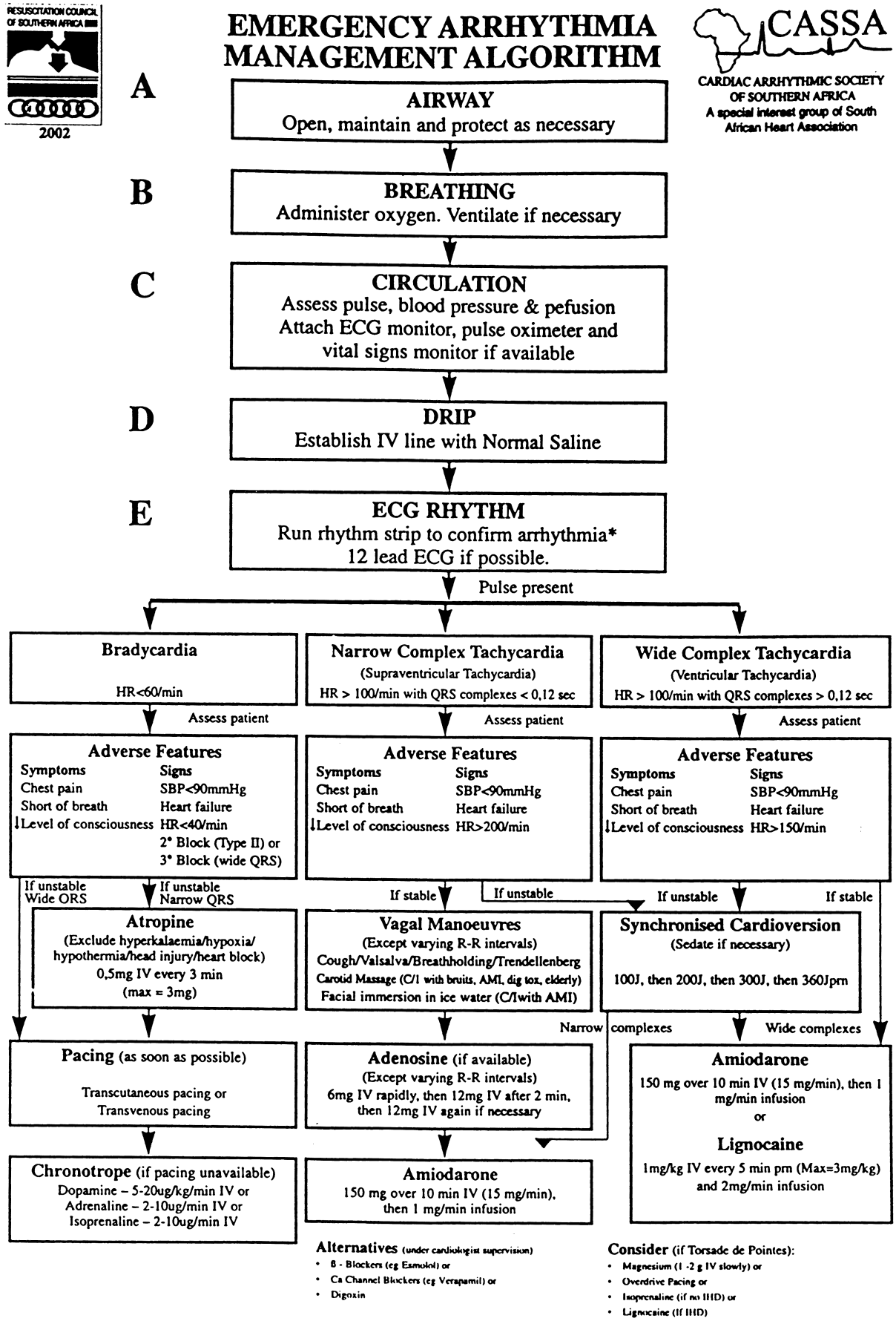
Interpretation of ECG

- Rate : slow or fast?
- Rhythm regular or irregular?
- QRS complex wide or narrow?

FURTHER READING:

EMERGENCY MEDICINE BY Moulton and Yates, Chapter 11, pages 139-159

EMERGENCY ARRHYTHMIA MANAGEMENT ALGORITHM



(The algorithm follows the assumption that the previous step was unsuccessful and the patient is deteriorating)

***NB: SPECIALIST MEDICAL ADVICE SHOULD BE SOUGHT WHENEVER POSSIBLE.**

4.2.5.4 HYPERTENSIVE EMERGNCIES

DEFINITIONS

- **Hypertensive Emergencies** = elevated blood pressure causing **end organ damage.**
- **Hypertensive Urgencies** = elevated blood pressure (usually with diastolic >115mmHg) but **no** end organ damage.
- **Transient Hypertension** = accompanies such conditions as pain, anxiety, alcohol withdrawal or intoxication, thrombotic stroke. Hypertension in these circumstances does **not** usually require treatment.

The classification and treatment of hypertensive emergencies does **not** only depend on the **level** of the blood pressure, eg, in pre-eclampia hypertensive encephalopathy may occur with a blood pressure of only 160/90.

CAUSES OF SUSTAINED HYPERTENSION

1. Essential
2. Renal eg, renal artery stenosis or diffuse renal disease
3. Endocrine eg, Cushings, Conns, Phaechromocytoma, Acromegaly
4. Pregnancy induced hypertension
5. Overdose of certain drugs eg, cocaine
6. Other
   - Coarctation of aorta
   - Neurogenic - from raised intracranial pressure
   - Intermittent porphyria

CLINICAL FEATURES

- **Patterns of "end organ" damage**
  - **CNS**

    Signs and symptoms can include headache, nausea, vomiting, transient or migratory focal neurological signs, confusion, coma

    It may be difficult to distinguish the cause and effect relationship between CNS dysfunction and hypertension. **CNS pathology (eg intracerebral haemorrhage) causing hypertension is much more common than vice-versa.**

  - **CVS**

    Signs and symptoms can include those of:

    Left ventricular failure

    Myocardial ischaemia or infarction

    Dissection of the thoracic aorta

  - **Renal**

    Acute deterioration in renal function as evidenced by rapidly rising serum creatinine and /or the presence of casts and protein in the urine.

IMPORTANT POINT

Treat the patient, not the blood pressure level.

MANAGEMENT

Initial Stabilisation

- Position patient
- Airway
- Breathing
- Disability
- Monitor

Directed History and Examination

Ask about

- **Event**, duration and mode of onset of symptoms
- **Symptoms**: chest pain, dyspnoea, visual disturbance, weakness, paraesthesia
- **Past History**

Look for

Heart failure, signs of dissection of the thoracic aorta, neurological signs, papiloedema, renal bruits.

Tests

Guided by which end organs have been damaged eg CXR, cerebral CT scan, urine microscopy looking for casts.

Specific Action

1. Hypertensive Emergencies

(a) LV failure or myocardial ischaemia / infarction

IV glyceral nitrate (GTN). Mix GTN in 50ml 5% dextrose water. Start at 1ml/hour, increase by 1ml every 5 min until symptoms resolve or BP < 120 systolic. Consider lasix, morphine and inotropes.

(b) Aortic dissection

GTN (as above) plus IV beta blockers (ensure no contraindications such as asthma, bradycardia or heart block).

(c) Hypertensive encephalopathy

Use GTN as above

There are serious risks of reducing blood pressure too quickly in this situation.

Aim to reduce mean arterial pressure by no more than 10% per hour. Do not reduce the pressure to < 25% of original level.

2. Hypertensive urgencies

(a) Ensure the hypertension is not transient by doing repeated measurements and by treating contributing factors eg pain.

(b) If the hypertension is found to be sustained, commence oral medications and aim to reduce BP to within normal range over 24 hours.

Aim to lower the blood pressure slowly over 48- 72 hours aiming for a diastolic reading of 100mmHg.

Treatment options are :

- ACE inhibitor e.g. Captopril
- Long acting calcium channel blockers
- Beta blockers

The effects of the above classes may be potentiated by the addition of a diuretic

Disposition

1. **Hypertensive emergencies**

   Admit all to an intensive care unit. If transfer is to occur, consider medical retrieval.

2. **Hypertensive urgencies**

   Observe in Emergency Department for 4-6 hours to ensure BP is falling

   If BP does not fall, admit

   If BP does fall, review in 24 hours.

Important Points

1. Treat the patient, not the blood pressure
2. More harm can be done by reducing grossly elevated blood pressure too quickly than by not treating at all.
3. Always consider that hypertension with no end organ damage may be transient and will respond to the control of contributing factors eg pain, anxiety.

FURTHER READING

Emergency Medicine, Chris Moulton and David Yates 2001
ISBN 0-632-02766-5, Chapters 11 and 12

A Guide to Management of Common Emergencies in Adults 2002
W.G.J Kloeck ISBN 1-874856-20-6, Pages 41-43

Chapter 5
DISABILITY

By the end of this chapter on neurological emergencies you should be able to :

- Demonstrate competence in the diagnosis, treatment and management of neurological emergencies including :
  - coma
  - stroke
  - altered mental status
  - seizures
  - head trauma
  - subarachnoid haemorrhage
  - meningitis
  - status epilepticus
- Demonstrate competence in the management of severe head injuries, including airway and ventilatory management.
- Undertake the following basic skills :
  - use of Glascow Coma Scale
  - initial assessment of head trauma
  - care of cervical spine injury or potential injury
  - care of the unconscious patient
  - care of the patient with altered conscious state
  - management of status epilepticus
- Undertake the following post basic skills
  - lumbar puncture
  - burr hole if necessary
  - administer thrombolytic therapy

5.1 THE UNCONSCIOUS PATIENT

DEFINITION

Altered levels of consciousness are best described by objective scales of responsiveness eg GCS. Avoid non-specific terms eg stupor, semi-conscious.

CAUSES

1. **Intracranial Causes**
   - Trauma
   - Haemorrhage (intracranial, subarachnoid)
   - Infections (meningitis)
   - Neoplasia (primary or secondary)
   - Seizures (ongoing fitting or post ictal state)

2. **Extracranial Causes**
   - Hypoxia / Hypercarbia
   - Hypotension
   - Hypoglycaemia
   - Hypothermia / Hyperthermia
   - Metabolic (uraemia, hyponatremia, myxoedema, hypercalcaemia)
   - Toxins / drug reactions (carbon monoxide, alcohol, opiates, tricyclics, benzodiazepines)
   - Environmental causes

CLINICAL FEATURES

Vary greatly, depending on the cause. However, regardless of the cause, the Glascow Coma Scale should always be recorded as this gives an objective measure of the level of consciousness and avoids non-specific terms.

IMPORTANT POINTS

A number of easily reversible conditions can cause unconsciousnes :

- Hypoxia / Hypercarbia
- Hypotension
- Hypoglycaemia
- Hypothermia / Hypothermia

MANAGEMENT OF THE UNCONSCIOUS PATIENT

Initial Stabilisation

1. **Position patient** - left lateral position
2. **Airway** - keep patent. **This is the cornerstone of the management of the unconscious patient.** Also, always remember to **protect the cervical spine with a hard collar** if there is a possibility of cervical spine injury.
3. **Breathing**
4. **Circulation**
5. **Disability** - record GCS and pupil response. **If the GCS is 8 or less, perform endotracheal intubation to protect the airway.**
6. **Measure** - temperature and blood sugar
7. **If narcotic overdose** is suspected (eg pin point pupils) give IV naloxone
8. **Monitor** - ECG, BP, SaO2

Directed History and Examination

Ask about :

- **Event**

  History from anyone available

- **Symptoms**

  which may have preceded the unconsciousness (eg headaches, fever, personality changes)

- **Past History**
  - chronic illness
  - diabetes
  - drug history

Look for

Any clues as to the cause eg neck stiffness, evidence of trauma, evidence of stroke, drug or alcohol ingestion.

Measure

- Response to above treatment ie measure heart rate, BP, blood sugar, GCS, SaO2
- Perform a 12 lead ECG
- Urinalysis

Tests

Guided by the suspected cause eg brain CT if trauma or haemorrhage is suspected.

Specific Treatment

Guided by the cause. For example, consider specific antidotes if poisoning is suspected, or antibiotics if meningitis is suspected.

Disposition

- Guided by the cause and response to treatment outlined above.
- Consultation and transfer should be considered early. If the patient is to be transferred and GCS is 8 or less, then a medical retrieval should be arranged.

Important Points

The commonest error made in the management of the unconscious patient is inadequate management of the airway, breathing and circulation, either initially or in the patient's subsequent transfer.

5.2 STATUS EPILEPTICUS

BACKGROUND INFORMATION

DEFINITION

Single episode of continuous seizure activity for greater than 30 minutes **or** more than two seizures without interim recovery of consciousness.

CAUSES

Similar list of causes to those of "The Unconscious Patient". Some of the common age related associations are :

Neonates	birth trauma and infections
Children	head trauma, infection, idiopathic epilepsy and congenital lesions
Young Adults	head trauma, alcohol withdrawal, drug toxicity, idiopathic
Middle age	alcohol withdrawal, CNS tumour or trauma, cardiac disease, idiopathic

CLINICAL FEATURES

These may be a combination of the features of:

1. **The Seizure**

   Can have convulsive features or non-convulsive features (eg petit mal and psychomotor). In children beware of the more subtle signs of ongoing convulsive epilepsy (eg unresponsiveness with eyes rolled back or deviated to one side, without twitching in the arms or legs).

2. **The Cause**

   CNS infection or trauma

3. **The Complications of the Seizure**

   Head trauma, musculoskeletal trauma, rhabdomyolysis, hyperthermia, hypoglycaemia, hypoxia, aspiration pneumonia.

IMPORTANT POINTS

1. Repeated or prolonged seizures can lead to brain damage via hypoxia, hyperthermia, hypoglycaemia and lactic acidosis.
2. Status epilepticus has a 10-20% mortality (1/3 of all epilepsy deaths are due to status epilepticus).

MANAGEMENT

Initial Stabilisation

1. **Position Patient** - left laterally
2. **Airway** - keep patent
   - **While seizure in progress**

     Position in the left lateral position with head in the sniffing position, gentle suction, oropharyngeal airway, or nasopharyngeal airway if the jaw is clenched. Do not force anything in the mouth.
   - **When seizure has stopped**

     Reassess the airway. It is often necessary to repeat the airway suction and the airway opening manoeuvres in the immediate post-ictal period.
3. **Breathing**
4. **Stop the seizure** - see drugs below.
5. **Circulation**
6. **Disability**

   Record GCS and pupils. Consider intubation if GCS equal or less than 8 and not improving. There is often a transient decreased level of consciousness from a combination of the post-ictal state and the effects of the anticonvulsant drugs that may have been given.
7. **Measure** - temperature, and do finger prick blood sugar.
8. **If Hypoglycaemia is present give 50% dextrose water** and re-check the blood sugar.
9. **Monitor** - ECG, BP, SaO2

Initial Seizure Control

1. Benzodiazepines

(a) Diazepam - 5-10mg IV (0.3mg/kg) is the drug of choice during seizures. Administer directly into infusion set every 15 - 30 seconds.

(b) Lorazepam - 1mg IV stat (0.05 - 0.1mg/kg) and repeated every 30-60 min as necessary can be used as an alternative.

2. Maintenance of seizure control and prophylaxis

- Phenytoin: 15mg/kg at 50mg/min, usually given after control of seizures with benzodiazepines. Monitor ECG continuously (watch out for hypotension, bradycardia and arrythmias)
- Other Drugs: Phenobarbitone - 10-20mg/kg if no response to Phenytoin

  If no response in 60 minutes, give Thiopentone 2-4mg/kg IV stat, followed by 1-2mg/hour in normal saline infusion, together with intubation and ventilation.

Directed History and Examination

ask about

- **Event**
  - history from anyone available
  - onset, description of seizures, duration, associated trauma
- **Symptoms**
  - prior to the seizure (eg fever, headache, personality change)
- **Past History**
  - previous seizure history
  - chronic illnesses
  - drug ingestion history

Look for

1. Subtle signs of ongoing seizures, especially in children
2. Clues as to the cause (stroke, neck stiffness, evidence of trauma, evidence of drug or alcohol ingestion)
3. Complications (eg head trauma, musculoskeletal trauma, rhabdomyolysis, hyperthermia, hypoglycaemia, hypoxia, aspiration pneumonia)

Measure

Response to above treatment, ie re-measure heart rate, BP, GCS, SaO2

Perform 12 lead ECG and urinalysis

Tests

- guided by the cause

Treatment considerations

1. Antibiotics if meningitis is a possibility. May be given prior to lumbar puncture.
2. Acyclovir IV where herpes is a possibility
3. Further IV glucose for hypoglycaemia
4. Oxygen for ongoing hypoxia
5. Specific antidote for suspected posoning
6. Treat any specific complications eg cool if hyperthermic, IV fluids for fluid depletion or rhabdomyolysis.
7. If the seizure has not stopped after 30 min with the treatment above, consider thiopentone and endotracheal intubation.

Disposition

Status epilepticus requires admission to a high care unit. If the patient is to be transferred, then medical retrieval will be necessary, especially if the patient is unstable or if the GCS is equal or less than 8.

Important Points

Principles of management are :

- To manage the airway, breathing and circulation
- To stop the seizure as soon as possible
- To treat any reversible causes eg hypoglycaemia
- Be aware of possible complications.

5.3 MENINGITIS

DEFINITION

Inflammation of the membranes of the brain and spinal cord.

CAUSES

1. Bacterial - common organisms

Adult

- Streptococcus pneumonia
- Neisseria meningitidis
- Haemophilus influenza
- M. tuberculosis
- Group A streptococci
- Gram negative (especially in the elderly)
- Listeria (especially in the elderly)

Children > 3 months af age

- Haemophilus influenza
- Strep. Pneumonia
- Neisseria meningitidis
- M tuberculosis

Neonates

- Group B streptococcus
- Non group B streptococci
- E coli
- Listeria
- Haemophilus / pneumococcus / meningococcus

2. Viral

- Mumps, measles, varicella
- Enteroviruses
- Herpes simplex
- Adenoviruses
- Influenza, parainfluenza

3. Fungal (especially in immunocompromised patients eg HIV)
Cryptococcus

4. Parasitic
Amoebe

CLINICAL FEATURES

Depends on age.

Neonates / Infants

Symptoms unreliable and non-specific

- poor feeding, limp, unresponsive
- fever or hypothermia
- increased irritability
- bulging fontanelle

Infants and Children

Classical signs become more reliable only in children >2 years.

- fever
- neck stiffness (rare under 2 years)
- headache
- personality changes
- altered level of consciousness
- focal neurological signs
- seizures

Adults

Differences in presentation between viral and bacterial meningitis

	BACTERIAL	VIRAL
Acute presentation (symptoms <24hours)	25%	5%
Headache	Prominent	Prominent
Meningeal signs	Common : 80%	Common : 30-40%
Fever	> 38.9 deg C	< 38.9 deg C
Alteration in mental status	80-90%	25-30%
Seizures	30%	5%
Focal neurological deficits	50%	< 10%

Special clinical association : Petechiae, purpuric or echymotic rash suggests meningococcaemia (but these rashes can also occur in other types of bacterial meningitis eg pneumococcal, haemophilus).

IMPORTANT POINTS

Children under 2 years can have an atypical presentation of meningitis. It should be suspected in all febrile children under 2 years of age until proven otherwise. That is, until another cause of fever is found, or after lumbar puncture has excluded meningitis.

MANAGEMENT

Initial Stabilisation

1. **Position Patient -** comfortably
2. **Airway**
3. **Breathing**
4. **Circulation**
5. **Disability**
6. **Measure** - temperature and finger prick blood sugar
7. **Monitor** - ECG, SaO2, BP

Directed History and Examination

Ask About

- **Event**

  History from anyone available

- **Symptoms**
  - headache
  - photophobia
  - neck stiffness
  - rate of onset

- **Past History**
  - chronic illnesses
  - drug history

Look For

- petechial rash
- evidence of fitting
- meningism
- focal neurological signs

Measure

Response to the above treatment if shock or hypoglycaemia were present ie re- measure pulse, BP, GCS

Tests

In acute presentations, IV antibiotics should be instituted within 30 min and sometimes before lumbar puncture and further investigations

Subacute presentations allow for a greater work-up time before initiating therapy

- **Contraindications to lumbar puncture :**
  - raised intracranial pressure eg GCS < 13, focal fitting or focal signs, papilloedema
  - a combative patient
  - bleeding disorder
  - inexperienced operator
  - overlying skin sepsis
  - distorted local anatomy

Specific Action Options are:

1. ***Immediate IV antibiotics with <u>no</u> lumbar puncture***

   In acute presentations with patients who are unwell and lumbar puncture is contraindicated or where there are no facilities for gram stain.

   OR

2. ***IV antibiotics and then CT scan prior to LP***

   In subacute presentations with clinical suspicion of other intracranial pathology eg profoundly depressed mental state with minimal or absent fever.

   OR

3. ***LP and then antibiotics prior to gram stain result***

   When there are no contraindications to LP and with a subacute presentation.

   - **Choice of antibiotics**

     Where the causative organism is not yet known (paediatric doses are given in brackets following the adult dose)

     Cefotaxime 200mg/kg day (200mg/kg day) up to a maximum of 12g/day IV in 3 or 4 divided doses

Or

Ceftriaxone 50mg/kg/day (100mg/kg/day) up to a maximum of 4g/day in 1 or 2 divided doses

Together with

Benzyl penicillin 180mg/kg/day up to a maximum of 12g/day IV in 6 divided doses (or 50,000-500,00u/kg/day)

Benzyl penicillin may be omitted in patients aged between 3 months and 15 years because it is added to cover Listeria which is resistant to cephalosporins. Listeria infection is unlikely in patients in this age group unless they are immunocompromised.

Because of increasing resistance, chloramphenicol should only be used when a third generation cephalosporin is contraindicated. eg due to hypersensitivity.

Either the penicillin or the cephalosporin should be ceased once the organism has been identified and susceptibility tests are available.

Further Considerations

1. Further IV fluids
   Once intravascular volume has been restored, fluid restrict the patient to half normal daily maintenance.
2. Chemoprophylaxis in household contacts and later for the patient in bacteriologically confirmed cases is recommended.
3. The use of steroids acutely and given prior to antibiotics is presently undergoing evaluation as a means of preventing the neurological sequelae of meningitis in children.

Disposition

All patients with meningitis should be admitted to a health facility capable of managing this condition.

Important Points

1. You do not need a LP to diagnose meningitis.

2. Sometimes a LP is contraindicated and can do harm as well as unnecessarily delay the institution of treatment.

5.4 HEAD INJURIES

5.4.1 Introduction

Primary damage to the brain occurs at the same time as injury. Secondary damage is the result of extracranial factors such as hypoxia or hypovolaemia, which leads to impaired cerebral perfusion and oxygen delivery. Re-perfusion of damaged brain is now recognized as an additional secondary factor, which can complicate recovery from traumatic brain injury. The problems which cause secondary damage, can be minimized by systemic resuscitation.

The situation in South Africa is that even with diminishing resources our hospitals are currently still able to provide a technologically advanced level of care for those with severe head injuries. However, they can no longer provide the very best, most expensive

treatment to **all** patients who appear at the doors. Academic medical training centres face the challenge of doing as much as possible for patients suffering from these injuries **and** a wide range of diseases, while maintaining the ability to train new generations of health care professionals to the highest standards of excellence.

During the past few years there has been an increasing incidence of severe head injuries presenting to South African hospitals - with many more due to road accidents and gunshot wounds.

Of the approximately 1000 patients admitted to Groote Schuur Hospital (GSH) with head injuries each year, about 150 fall into the category of 'severe head injury' as defined by a Glascow Coma Scale score of 5 or less, 6 hours after resuscitation.

In 1999, 55% of all surgical operations undertaken at GSH were for trauma, as compared with only 45% for elective operations for patients suffering from a range of surgically treatable diseases. This can be compared to a country such as Holland where only 5% of surgical operations are for traumatic injuries. The excessive and growing trauma load at GSH results in less surgical time for non trauma patients, and hence denial of effective treatment to many patients who would otherwise have benefited from access to effective and relatively inexpensive care, for example cataract operations.

5.4.2 Prognosis for Head Injured Patients

Data from studies conducted in highly resourced countries and South Africa suggest that patients with severe head injuries with GCS scores of 5 or less post-resuscitation have a significantly lower prospect of survival or satisfactory outcome than those who have higher GCS scores. In a US prospective study of 746 consecutive patients with severe closed head injuries, 290 had a GCS score of 5 or less. In this group 59% of patients died, 8% survived in a persistent vegetative state and 26% survived with persisting moderate or severe morbidity. In only 7% of patients was there a so-called 'good' outcome, defined as the ability to function in a basically independent fashion.

In another US study of penetrating craniocerebral injuries (gunshot wounds), only 2 of 60 patients with admission GCS scores of 5 or less who had operative intervention had good outcomes.

A study conducted in KwaZulu-Natal between 1989 and 1993 to evaluate the outcome of patients with GCS scores of 3-4 as compared with scores of 5-7, showed that there was a 73% mortality rate for those with a score of 3 or less on admission and a 93% bad outcome. This trend progressively improved with higher GCS scores on admission, to the point where patients with scores of 7 on admission had a 16% mortality and a 47% bad outcome.

5.4.3 Policy Proposal for Head Injuries

BIOETHICS CENTRE, UNIVERSITY OF CAPE TOWN

Dept of Neurosurgery, University of Cape Town and GSH hospital

1. To give all head injured patients the best chance of survival, all head injury patients presenting to the hospital will be resuscitated, intubated and ventilated , if necessary. They will be evaluated with computed tomography (CT) scans for potentially treatable surgical lesions, and observed for their early responses.
2. Within 24 hours, the team, inclusive of senior and experienced staff, will take a carefully measured decision on the basis of all available information, including medical indications such as GCS scores and CT scans findings, the patient's anticipated quality of life, patient and family perferences and support capability, and the availability of resources to sustain the patient's treatment and rehabilitation.

Patients who are judged to have good outcomes, after considering all relevant factors and information, will continue to receive aggressive treatment.

Patients who are judged to have poor outcomes, after considering all relevant factors and information, may have aggressive treatment, including ventilation and artificial nutrition, withheld or withdrawn.

3. A full and sensitive communication with all staff and the family or surrogate is essential.
4. Where there are disagreements between staff members or between caregivers and the family or surrogate, a process for resolving such disagreement quickly and fairly must be available.
5. Where patients cannot be offered aggressive treatment, they will be provided the best possible comfort care. GSH will assist any family or surrogate to transfer the patient to another facility, if this is requested and feasible.

5.4.4 Ethical Considerations

While in the past the ethics of medical care was concerned almost entirely with debating and implementing decisions determined by medical indications and patient preferences, it is now necessary to face the fact that other factors do come into the decision making process. It is no longer possible to avoid considerations of quality of life and external factors such as availability of resources and the need to retain balanced services. As budget cuts escalate and public institutions consider ways to allocate their shrinking resources, they have drawn on models of rationing that utilize cost-benefit approaches which either expressly or implicitly select patients for the best and most expensive treatments based on evaluations of their quality of life.

The medical profession should take responsibility for doing the best it can with available facilities for all patients; the public should be aware of the limits of what medicine can offer, especially under conditions of severe resource constraint; and politicians responsible for making policy regarding the distribution of resources should understand and be accountable for the implications of their decisions.

5.4.5 Approach to Head Injuries

Please read the chapter on Head Injuries in Emergency Medicine by Moulton and Yates, Chapter 3, pages 31-46.

Chapter 6
ABDOMEN

EVALUATION AND MANAGEMENT OF ABDOMINAL TRAUMA AND ABDOMINAL PAIN

By the end of this chapter you should be able to:

- Demonstrate competence in the assessment, appropriate management, referral and transfer of abdominal emergencies including the acute abdomen and abdominal trauma

6.1 ABDOMINAL TRAUMA

6.1.1 Introduction

Dealing with abdominal trauma constitutes a significant part of workload in many parts of the world, none more so than in South Africa. Abdominal trauma can be broadly divided into penetrating and blunt injuries, and from the anatomical point of view into intra-peritoneal, retro-peritoneal and pelvic injuries. Penetrating trauma is usually due to stab wounds, and, increasingly in South Africa, gunshot wounds. Blunt abdominal trauma can be encountered in motor vehicle accidents, falls, assaults, and occupational accidents. The identification and evaluation of intra-abdominal injury with blunt trauma can be very difficult, and is not infrequently associated with injuries elsewhere such as in the head, chest and limbs.

6.1.2 Blunt Abdominal Trauma

In the assessment of these patients it is not only important to diagnose specific organ injury, but also to consider whether emergency laparotomy needs to be performed. Severe internal abdominal injuries are sometimes not suspected when external signs of trauma are absent or when a history of trauma is not reported.

Blunt trauma to the abdomen is more likely than penetrating wounds to damage solid organs. Diagnostic peritoneal lavage (DPL), CT scan and ultrasound have evolved as useful adjuncts to clinical decision making for blunt abdominal injuries.

Injured children represent a unique sub-population of trauma patients in whom the assessment of abdominal injuries can be even more difficult , especially in multisystem trauma patients.

6.1.2.1 HISTORY

Skill is needed to obtain a significant or relevant history in the trauma patient. The mechanism of injury may give clues about possible abdominal injuries. These patients should be managed with a high degree of suspicion, close observation and repeated physical examination (by the same physician), and laboratory and ultrasound examinations. History taking is often limited by head injury, alcohol and drugs.

6.1.2.2 PHYSICAL EXAMINATION

The initial abdominal examination following blunt trauma can be unreliable. Injuries to the head, spinal cord, chest, pelvis, fractures as well as alcohol and drugs can limit the sensitivity of the physical examination. Alert patients with abdominal bleeding may

initially be asymptomatic because blood is not strongly irritant to the peritoneum, and venous haemorrhage may take hours before clinical signs become obvious. Patients with orthopaedic injuries requiring early operation are less accessible for observation and monitoring is more difficult. Echymoses or abrasions to the trunk may be a useful clue to an underlying intra-abdominal injury. Abdominal guarding, tenderness (including rebound), are important but generally late signs. A rectal examination may reveal blood or high riding prostate, while a vaginal examination may demonstrate vaginal injuries, especially accompanying pelvic fractures.

The presence of hypovolaemia may be the only suggestion of intra-abdominal haemorrhage. Pain referred to the left shoulder may indicate splenic injury, and pain in the right shoulder hepatic injury. Unstable haemodynamics, abdominal distension, peritoneal signs and falling haematocrit are indications for immediate laparotomy. Regular recordings of blood pressure, pulse and temperature are important. Re-assessment of the abdomen, preferably by the same doctor, is paramount.

6.1.2.3 LABORATORY INVESTIGATIONS

Haematological and blood chemistry investigations are of limited value immediately after the accident, but baseline results are useful for subsequent comparisons eg serial haematocrit levels.

Serum amylase levels may be measured in patients with epigastric trauma as it may be raised in 70% of blunt pancreatic injuries. Non specific leucocytosis is common after blunt trauma. Human chorionic gonadotrophin to exclude pregnancy should always be part of tests in female patients of child bearing age. Blood should be sent for cross match and routine urinalysis should be performed.

6.1.2.4 SPECIAL INVESTIGATIONS

Diagnostic procedures should only be done on **fairly stable patients.** If the patient clearly needs a laparotomy, undue delay for investigations is not warranted.

PLAIN X-RAYS

All patients should undergo X-rays of cervical spine, chest and pelvis, with additional films based on suspicion of injury. Plain abdominal X-rays can be useful to detect fractures of lower ribs, vertebral fractures (including transverse processes), and traumatic diaphragmatic rupture.

Free intra-peritoneal or retro-peritoneal air which is diagnostic of a ruptured viscus, can be demonstrated. The erect chest X-ray and the left side down lateral decubitus abdominal X-rays are the most useful views to detect free air. In the supine view detection of free air is more difficult but Rigler's sign is gas on either side of the bowel wall and the falciform ligament of the liver may also be outlined in the right upper quadrant. The sensitivity for free air under the diaphragm in small bowel injuries is reported to be less than 30%. The reason is that some intestinal perforations might not create enough air to be detected in the early period after trauma. To detect intra-abdominal bleeding or organ injury with plain X-ray is of no practical value, 800ml of fluid is the smallest amount that can be detected.

INTRAVENOUS PYELOGRAM (IVP) AND CYSTOGRAPHY

The indications for IVP and cystography are controversial. IVP can be performed in a patient with gross haematuria (>200 red cells/high power field) when there are associated clinical findings that suggest significant injury. Cystography in blunt trauma should be restricted to patients with gross haematuria and/or the presence of a pelvic fracture.

DIAGNOSTIC PERITONEAL LAVAGE (DPL)

Before 1994, DPL was considered the standard tool for evaluation of patients with blunt abdominal trauma, being both sensitive and specific for detecting occult intra-abdominal injuries (it can detect 20 ml of blood). Since that time, CT and US have replaced DPL as the preferred diagnostic aid in the First World. DPL is now used primarily as a triage tool in the adult patient with multiple injuries who shows signs of instability in the emergency department, especially where injuries are above and below the abdomen. The draw back of DPL is that it is an invasive procedure and may be overly sensitive, resulting in negative findings at laparotomy. It is also not useful for evaluation of retroperitoneal structures. DPL has relative contraindications in those patients who have had previous laparotomies and in pregnancy.

DIAGNOSTIC ULTRASOUND (US)

Ultrasound technology has become increasingly sophisticated, and portable equipment has made it easy and inexpensive for clinicians to use this method during initial evaluation of trauma patients as well as in subsequent patient monitoring. The primary goals of the initial US examination are to detect haemoperitoneum and to estimate the volume of intraperitoneal fluid. This information is essential to determine whether management should be operative or non-operative and to establish the need for further investigations (imaging modalities).

Large or increasing amounts of intraperitoneal free fluid are indications for laparotomy. Numerous investigators have demonstrated that emergency department US can be as sensitive as DPL in the recognition of haemoperitoneum. Specificity and accuracy are also good. US has also been used to show the extent and location of organ haematomas and to detect retroperitoneal haematomas. It can be performed simultaneously with the physical examination, resuscitation and stabilization within minutes of the patient's arrival in the emergency department.

US is not as sensitive for specific organ injury as CT. Obesity, subcutaneous emphysema and open wounds can limit imaging of the abdomen. It is also unreliable in identifying bowel injuries, and it is difficult to obtain direct sonographic findings of injuries in organs such as the mesentary, diaphragm, bladder and aorta, athough fluid collection can be detected.

US would be especially indicated in pregnancy and in patients allergic to contrast media.

COMPUTED TOMOGRAPHY (CT)

CT has been used in the assessment of patients with blunt abdominal trauma for two decades with reported accuracy as high as 98%. The advantages of CT scanning are its relative non-invasiveness and the ability to evaluate retroperitoneal structures and to identify specific organ injuries that can aid in the decision to manage patients non-operatively. Free fluid on CT is 90% predictive of occult injury in the abdomen.

However, CT is time consuming, requires patient transport and sedation, and may leave patients vulnerable during the scanning period when they cannot be monitored closely or resuscitated adequately, making it specifically risky and not advisable in the unstable patient. In addition, CT is costly, especially if used routinely as a triage tool in paediatric patients when physical examination is not reliable and DPL is not warranted. It also does not always diagnose diaphragmatic or hollow viscus perforations.

6.1.3 Specific Abdominal Injuries

6.1.3.1 SPLENIC AND LIVER INJURIES

These are the most commonly injured organs, especially in children. Slow bleeding may cause minimal peritoneal signs in the first few hours after injury. The severity of injury may not be recognized because hypotension may have been corrected by fluids during initial resuscitation.

SPECIAL INVESTIGATIONS :

- US during initial resuscitation for the detection of fluid
- CT when stabilized for estimation of fluid, location and extent of organ injury
- DPL in unstable patients without peritonitis, abdominal distension or obvious visceral injury when no US is available.

6.1.3.2 URINARY TRACT INJURIES

Haematuria is the most common indication of injury. In future IVP may be replaced by CT and contrast. Bladder injury should be suspected in cases of :

- haematuria
- inability to pass urine
- pelvic fractures

A cystogram is indicated in these patients.

Where X-rays show fractures of the transverse processes of the lumbar vertebrae, ureteric injuries should be excluded with IVP.

6.1.3.3 PANCREATIC INJURIES

These injuries are rare and difficult to diagnose. They can be associated with duodenal injuries.

CT may be of value.

6.1.3.4 BOWEL INJURIES

Bowel injuries are often occult and difficult to diagnose. Repeated bedside evaluation and physical examination are essential.

Special investigations:

- X-rays are positive in 30% of cases
- CT is unreliable and is positive in less than 40% of cases.
- DPL can be valuable
- Laparotomy remains the best test to ensure the patient's safety if uncertainty persists.

6.1.4 Conclusion

There are many pitfalls in identifying occult injuries of the abdomen after blunt trauma. As physical examination may be unreliable, other diagnostic modalities can be very useful and should be complementary and not competitive to each other.

FOR FURTHER READING ON ABDOMINAL INJURIES :

Emergency Medicine by Moulton and Yates Chapter 6, Pages 75 to 80

ABDOMINAL PAIN READING :

Emergency Medicine by Moulton and Yates Chapter 16, Pages 237 to 246

Chapter 7
TRANSFERS AND RETRIEVALS

Safe transport of the seriously ill patient requires accurate **assessment** and **stabilization** of the patient **prior to transport.**

Prior to arrival of the retrieval team, **the referring doctor has the primary responsibility for patient care** and should ensure clinical stability and appropriate monitoring.

7.1 TYPES OF RETRIEVALS

1. **PRIMARY RESPONSE - FROM THE SCENE OF THE ACCIDENT:**
   - trapped with severe injuries where extended delays are anticipated
   - ambulance resources are sufficient for adequate care

2. **SECONDARY RESPONSE - BETWEEN HOSPITALS :**
   - Where the condition of the patient requires stabilization prior to or during transport.

7.2 INDICATIONS FOR MEDICAL RETRIEVAL

Some indications for transfers and retrievals:

AIRWAY

- all intubated patients
- actual or potential need for intubation
- upper airway obstruction
- facial or airway burns
- facial trauma
- epiglottis, severe croup

BREATHING

- acute severe asthma
- severe pulmonary oedema

CIRCULATION

- acute myocardial infarction complicated by shock or arrythmia
- unstable cardiac rhythm
- complete heart block with hypotension
- complex monitoring required
- transvenous pacing required
- unstable patient requiring inotropes or volume resuscitation
- ruptured aortic aneurysm
- shock from any cause

DISABILITY

- GCS 8 or below, or falling by 2 or more points
- continuous or repeated seizures

TRAUMA

- head injury with altered level of consciousness and GCS of 8 or less
- multiple trauma including 2 or more long bone fractures, pelvic fractures
- patients with systolic BP < 90 after initial resuscitation
- spinal injury or suspected unstable spinal fracture
- major facial trauma
- burns > 20%
- face, neck and respiratory burns
- meningitis/septicaemia
- major chest or abdominal injury

NEONATAL

- inspired oxygen requirement > 40%
- birth weight < 1500g
- actual need or potential need for intubation and mechanical ventilation

PAEDIATRIC

- as for adult
- epiglottis/severe croup
- severe asthma
- respiratory disease of any cause
- shock or severe dehydration
- meningitis/septicaemia

OTHER

- envenomation
- poisoning requiring intensive therapy
- obstetric emergencies - severe pre-eclampsia/eclampsia, APH. PPH

7.3 RESPONSIBILITIES OF REFERRING DOCTOR

The patient should be resuscitated and attempts made to stabilize as completely as possible prior to the arrival of the retrieval team. This may need to be done in consultation with the retrieval consultant.

7.3.1 Notification of Retrieval Service

This should be done as soon as possible after medical assessment, but should not interfere with any immediate life saving interventions which are necessary. At notification, the retrieval service will need the following information:

- name, age and sex of patient
- history of incident, mechanism of accident or nature of illness
- initial findings or assessment, including relevant pre-hospital data
- procedures performed and treatment given

7.3.2 Checklist for the Referring Doctor

Prior to the arrival of the retrieval doctor, the referring doctor should address the following areas:

AIRWAY AND BREATHING

- Airway should be patent and protected before transport
- If patient can't keep airway patent or protected, endotracheal intubation may be necessary
- Insert oropharyngeal or nasopharyngeal airway if needed
- Secure the ETT with tie and tape
- Check position of ETT
- Remember, in head trauma a cervical spine injury may co-exist, so immobilize the spine with a hard collar
- Insert a chest drain if needed. Patients with haemothorax or pneumothorax must have a chest tube inserted if mechanical ventilation is to be instituted.
- Insert nasogastric tube in intubated patients to prevent aspiration

CIRCULATION

- Control external bleeding
- Establish two large bore IV lines and begin infusion, if indicated, to maintain pulse and blood pressure
- Replace volume losses with crystalloid or blood
- Insert catheter to monitor urine output
- Monitor patients BP, pulse, ECG

DISABILITY

- Controlled hyperventilation to pCO2 of 30-35 is indicated for severe head injuries with GCS 8 or below (this is being disputed in some centres)
- Administer mannitol or diuretics IV after neurosurgical consultation
- Immobilize head, neck, thoracic and lumbar spines

WOUNDS

- Clean and dress
- Tetanus toxoid and tetanus immune globulin if indicated
- Antibiotics where indicated

FRACTURES

- Appropriate splinting and traction eg Thomas splint for femoral shaft fractures
- Backboard when lumbar or thoracic spine injury
- Displaced fractures should be realigned and splinted
- Mast suit is useful to splint pelvic and femur fractures and to reduce blood loss

  Mast suit should be used with caution.

DIAGNOSTIC STUDIES AS INDICATED AND IF AVAILABLE

Xray

- cervical spine
- chest
- pelvis

Laboratory

- FBC
- Blood sugar
- Arterial Blood Gases
- X-match

Other

- ECG
- Urinalysis

Do not waste time on investigations that will not change your management.

IMPORTANT POINTS

The arrival of the retrieval team can sometimes take some hours. During this time the patient's condition should be continually checked and re-checked. This is the responsibility of the referring doctor.

TOPICS FOR READING

TOPICS NOT COVERED IN THIS MANUAL, FOR READING:

All in C. Moult and D. Yates: *Emergency Medicine*

1. **Burns**
   Chapter 10 p.130.
2. **Poisoning**
   Chapter 15 p.213.
3. **Obstetric, gynaecological, genitourinary and perineal problems**
   Chapter 17 p.247.
4. **The disturbed patient**
   Chapter 19 p.279.
5. **Ophthalmic, ENT and facial conditions**
   Chapter 22 p.333.